THUNDER AND LIGHTNING

CAMILLE FLAMMARION

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BY

CAMILLE FLAMMARION

TRANSLATED BY WALTER MOSTYN

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THUNDER AND LIGHTNING

CHAPTER I

THE VICTIMS OF LIGHTNING

It would be an interesting thing to make a careful study once a year, towards the end of the summer, of the habits and customs of thunder and lightning. Perhaps in this way we should succeed one day in determining the still mysterious nature of these elusive forces. I, for my part, have been engaged upon the task for many years past. It has produced a big accumulation of records, and in this volume I can find room but for a *résumé* of them, as varied as possible. In my first chapter I shall present a few characteristic examples, just to give my readers some hint of this variety.

Not to go too far back, let us begin with a harmless —I might almost say playful—fireball performance, of which M. Schnaufer, Professor at Marseilles, has given me the particulars.

In October, 1898, the fireball in question made

its appearance in a room and advanced towards a young girl who was seated at the table, her feet hanging down without touching the floor. The luminous globe moved along the floor in the girl's direction, began to rise quite near her and then round and round her, spiral fashion, darted off towards a hole in the chimney—a hole made for the stove-pipe, and closed up with glued paper—made its way up the chimney, and, on emerging into the open air, gave out upon the roof an appalling crash which shook the entire house. It was a case of coming in like a lamb and going out like a lion!

A similar occurrence is recorded as having been observed in Paris, on July 5, 1852, in a tailor's room, including the same curious detail of the departure through the hole in the chimney, closed up with paper.

It was in the Rue Saint Jacques, near the Val de Grâce. The fireball burst into the room from the chimney, knocking over the paper guard in front of the fireplace. In appearance it suggested a young cat, gathered up into a ball, as it were, and moving along without using its paws. It approached the tailor's legs as though to play with them. The tailor moved them away to avoid the contact, of which he naturally was in terror. After some seconds, the globe of fire rose vertically to the height of the man's face as he sat, and he, to save himself, leaned quickly back and

fell over. The fireball continued to rise, and made its way towards a hole which had been made at the top of the chimney for the insertion of a stove-pipe in the winter, but which, as the tailor put it afterwards, "the fireball couldn't see," because it was closed up with paper. The ball stripped off the paper neatly, entered the chimney quite quietly, and having risen to the summit, produced a tremendous explosion, which sent the chimney-top flying, and scattered it in bits all over the neighbouring courtyard and surrounding roofs.

There we have a unique occurrence, recorded for us by Babinet and Arago, and of which I have given here the exact particulars. In both these cases we have to note the attraction of the hole in the chimney and the explosion of the thunderbolt on getting to the top. But it is not easy to detect the law underlying these phenomena.

In one of the latest volumes of the Association Française a somewhat similar case is dealt with.

"A violent storm," says the writer, M. Wander, "had descended upon the commune of Beugnon (Deux-Sèvres). I happened to be passing through a farm, in which were two children of about twelve and thirteen. These children were taking refuge from the rain under the door of a stable, in which were twenty-five oxen. In front of them extended a courtyard,

sloping downwards towards a large pond, twenty or thirty yards away, beside which grew a poplar-tree. Suddenly there appeared a globe of fire, of the size of an apple, near the top of the poplar. We saw it descend, branch by branch, and then down the trunk. It moved along the courtyard *very slowly*, seeming almost to pick its way between the pools of water, and came up to the door where stood the children. One of them was bold enough to touch it with his foot. Immediately a terrible crash shook the entire farm to its foundations, the two children were thrown to the ground uninjured, but eleven of the animals in the stable were killed!"

Who is to explain these anomalies? The child who touched the fireball escapes with a fright, and a few feet behind him eleven animals out of twenty-five perish on the spot!

During the storm which broke out at the town of Gray, on July 7, 1886, my friend M. Vannesson, President of the Tribunal, saw a fireball of from thirty to forty centimetres in diameter, which exploded on the corner of a roof, cutting clean off the end portion of the central beam to the length of about half a yard (like a bundle of matches, but without setting it on fire), scattering the splinters over the upper story and loosening the plaster upon the walls below. It then *rebounded* on the roofing of a little outside

staircase, made a hole in it, smashing and sending flying the slates, came down upon the road, and rolling right in the midst of some passers-by—who, like the child in the farm, escaped with a fright—disappeared.

My learned fellow-member of the Astronomical Society of France, Dr. Bougon, has discovered an account of one of the most remarkable fireballs ever recorded in *La Gloire des Confesseurs*, a work written by Gregory of Tours, the twentieth bishop of that town.

On the dedication day of an oratory which he had constructed in one of the outer buildings of the episcopal palace, all the participants in the procession from the cathedral, while approaching the oratory with the sacred relics and singing the litanies, saw a globe of fire, so intensely brilliant that their eyes were dazzled, and they could scarcely keep them open. Seized with terror, priests, deacons, sub-deacons, choristers, together with the distinguished citizens of the town, who were carrying the relics upon their shoulders, all with one accord threw themselves on the ground, face downward. Then Gregory, remembering that on the occasion of the death of St. Martin, some of whose bones were among the relics being carried from the cathedral, a globe of fire was said to have been observed to leave the saint's head and ascend heavenwards, believed himself to be in the presence

of a miracle, vouchsafed as evidence at once of St. Martin's sanctity and the genuineness of his relics. This globe of fire did no damage and burnt nothing. *Discurrebat autem per totam cellulam,* TANQUAM FULGUR, *globus igneus.*

There is to be seen at the Louvre a picture by Eustache Lesueur, entitled "La Messe de Saint Martin," which seemed to me at first to illustrate this narrative, but the spectators are shown in silent wonder instead of being prostrated as in the story. Moreover, Gregory of Tours tells us in his life of St. Martin, that one day during Mass a globe of fire was seen to appear above the head of the bishop, and then to rise heavenwards, to the great edification of the devout. It was this "miracle," evidently, that Lesueur intended to represent.

Here is another case of a remarkably harmless fireball which is often cited.

The Abbé Spallanzani it is who tells the story. On August 29, 1791, a young peasant woman was in a field during a storm, when suddenly there appeared at her feet a globe of fire of about the size of a billiard ball. Slipping along the ground, this little fireball reached her feet, caressed them, as it were, made its way up under her clothes, and issued again from the middle of her bodice, and, still keeping its globular form, darted off into the air and exploded noisily.

When it got under her petticoats, they blew out like an umbrella, and she fell back. Two witnesses of the scene ran to her assistance, but she was unhurt. A medical examination revealed only a slight erosion of the skin, extending from the right knee to the middle of her breast; her chemise had been torn in two along the same line, and there was a hole through her bodice where the thunderbolt had got out.

In the "Memoirs of Du Bellay" the following very curious narrative is to be found. In all probability it is a fireball that is in question:—

"On March 3, 1557, Diane of France, illegitimate daughter of Henri II., then the Dauphin, married François de Montmorency. On the night of their wedding, an oscillating flame came into their bedroom through the window, went from corner to corner, and finally to the nuptial bed, where it burnt Diane's hair and night attire. It did them no other harm, but their terror can be imagined."

Perhaps it may be as well to take with a pinch of salt the statement that the lady's attire was burnt in this way without harm to her person, yet there are other authentic stories of a similar kind almost as curious.

In 1897, at Linguy (Eure-et-Loire), a man and his wife were sleeping quietly, when suddenly a terrible crash made them jump out of bed. They thought

their last hour had come. The chimney, broken to pieces, had fallen in and its wreckage filled the room, the gable-end was put out and the roof threatened to come down. The effects of the thunderbolt in the room itself were less alarming than its effects outside, but were very curious. For instance, bricks from one wall had been dashed horizontally against the wall opposite, with such extraordinary force that they were to be seen imbedded in it up above a dresser upon which pots and pans, etc., were ranged, and within a few inches of the ceiling, while the windows of the room had been smashed into bits, and a looking-glass, detached from the wall, stood on end whole and entire upon the floor, delicately balanced. A chair near the bed, upon which articles of clothing had been placed, had been spirited away to a spot near the door. A small lamp and a box of matches were to be found undamaged upon the floor. An old gun, suspended from a beam, was violently shaken and had lost its ramrod.

The thunderbolt actually frolicked over the bed, leaving its occupants more dead than alive from terror but quite unhurt. It passed within a few inches of their heads and passed through a fissure in a partition into an adjoining dairy, where it carried a whole row of milk-cans, full of milk, from one side of the room to another, breaking the lids but not upsetting a single can. It broke four plates out of a pile of a dozen,

leaving the remaining eight intact. It carried away the tap from a small barrel of wine, which emptied itself in consequence.

It ended by passing out through the window without further breakage, leaving the husband and wife unscathed but panic-stricken.

One of the strangest tricks to which lightning is addicted is that of undressing its victims. It displays much more skill and cleverness in such diversions than is to be found in animals or even in many human beings.

Here is one of the most curious instances of this on record, as narrated by Morand :—

"A woman in man's costume. A storm suddenly comes on. A flash of lightning strikes her, carries off and destroys her clothes and boots. She is left stark naked, and she has to be wrapped up in a cloth and taken thus to the neighbouring village."

In 1898, at Courcelles-les-Sens, Mlles. Philomène Escalbert, aged 19, Adèle Delauffre, aged 22, and Madame Léonie Legère, aged 44, were standing round a reaping-machine, when a flash of lightning struck Madame Legère and killed her on the spot. The two young girls were stripped to the skin, even their boots being torn from their feet. Otherwise they were left safe and sound—and astonished.

On October 1, 1868, seven persons took refuge

during a storm under a huge ash-tree near the village of Bonello, in the Commune of Perret (Côtes-du-Nord), when suddenly the tree was struck by lightning, and one of them—a woman—was killed. The six others were knocked to the ground without being seriously damaged. The clothes of the woman who had been killed were torn into shreds, many of which were found clinging to the branches of the tree.

On May 11, 1869, a farmer at Ardillats was tilling the ground with his two oxen, not far from his dwelling-place, about four in the afternoon. The air was close and heavy, and the sky covered with black clouds. Suddenly there was a great thunderclap, and a flash of lightning struck both man and beasts dead on the spot. The man was found stripped to the skin, and his boots had been carried thirty yards away.

In July, 1896, at Epervans (Saône-et-Loire), a young man named Petiot, who was mowing in a meadow, was struck dead by lightning while lighting a cigarette, and left in a state of complete nakedness.

On August 11, 1855, a man was struck by lightning near Vallerois (Haute-Saône), and stripped naked. All that could be found afterwards of his clothes was a shirt-sleeve, a few other shreds, and some pieces of his hobnailed boots. Ten minutes after he was struck he regained consciousness, opened his eyes, complained of the cold, and inquired how he happened to be naked.

There is no telling what lightning will not do.

Sometimes it will snatch things out of your hand and carry them right away.

There is a case of a mug being thus spirited away from a man, who had just been drinking out of it, and deposited undamaged in a courtyard near—the man himself suffering no injury. A youth of eighteen, holding up a missal from which he is singing, has it torn out of his hands and destroyed. A whip is whisked out of a rider's hand. Two ladies, quietly knitting, have their knitting-needles stolen. A girl was sitting at her sewing-machine, a pair of scissors in her hand; a flash of lightning, and her scissors are gone and she is sitting *on* the sewing-machine. A farmer's labourer is carrying a pitchfork on his shoulder; the lightning seizes it, carries it off fifty yards or so, and twists its two prongs into corkscrews.

On July 22, 1878, at Gien (Nievre), a woman while sprinkling her house with holy water during a storm, saw her holy-water bottle smashed actually in her fingers by the lightning, which at the same time smashed up the tiled pavement of the room.

In a church at Dancé (Loire) during vespers, one day in June, 1866, a flash of lightning killed the priest and all the congregation, knocked over the monstrance on the altar, and buried the Host in a heap of *débris*.

On June 28, 1885, the cupola of the Javisy

Observatory, which was not then provided with a lightning conductor, was struck by lightning. An enormous piece of oak from *un angle de construction* was torn to shreds, and one splinter was lodged in the hinge of a window behind the *pivot*, in the part between the *pivot* and the frame, hardly a twenty-fifth of an inch apart, and this without breaking the glass.

In other cases lightning has been known to split men in two, almost as with a huge axe. On January 20, 1868, this happened to a miller's assistant in a windmill at Groix. The lightning struck him, and split him from his head downwards in two.

In the course of July, 1844, four inhabitants of Heiltz-le-Maurupt, near Vitry-le-Françoise, took refuge under trees during a storm, three of them under a poplar, and the fourth under a willow, against which doubtless he leaned. In a few minutes this one was struck by lightning. A bright flame was observed to be issuing from his clothes, but he remained standing, and seemed unconscious of what had happened. "You're on fire! You're on fire!" exclaimed his friends. Getting no reply, they went up to where he was, and found to their horror that he was a corpse.

A clergyman named Butler was a witness of the following incident, which took place at Everdon. Ten harvest-men took refuge under a lodge on the approach of a storm. There was a thunderclap, and in a moment

four of them were killed by lightning. One of them was found dead, still holding between finger and thumb a pinch of snuff he had been in the act of taking. A second had one hand upon the head of a small dog, also killed, and still sitting upon his knees, and in the other hand a piece of bread; a third was sitting, his eyes open, facing in the direction from which the storm came.

At Castellane, in August, 1898, during a violent storm, a flock of sheep was struck by lightning while crossing the mountain of Peyresy. Seventy-five of them were killed. The shepherd escaped. The sheep probably were all wet from the rain, and clinging together in one great mass. In the same month a pond at Vauxdîmes (Côte-d'Or) was demolished, and all the fish in it killed.

Quite recently, a young man at Franxault (Côte-d'Or) was killed by lightning on his way home from work. All the nails were found to have been torn out of his shoes, and the links of his silver watch-chain were all moulded together. To fuse silver in this way a heat of 957 degrees is needed!

On July 5, 1883, at Buffon (Côte-d'Or), a woman had one of her earrings melted in the same way, but she was not killed. On the same day at Void (Meuse) two workmen, who had taken shelter under a willow, were thrown a distance of four yards without being killed.

On August 10, of the same year, at Chanvres (Yonne), a vine-dresser was struck by lightning and killed, but his heart continued to beat for thirty hours.

Dr. Gaultier de Claubry was struck by lightning, with the extraordinary result that his beard was taken off him, roots and all, so that it never grew again.

At Fresneaux (Oise), a young girl of twenty, Mlle. Laure Leloup, had her head shorn by lightning. A wide furrow was to be traced on the crown of her head, caused by the electric fluid. Her hair was removed right down to the skin as though by a razor.

On September 4, 1898, a flash of lightning lit up all the electric lamps in the Prefecture of Lyon.

Really it is extraordinary the queer things lightning will do! Death in one case, an innocent practical joke in another! I have hundreds of quaint records before me. Impossible to deduce any kind of law from them all. You are tempted to believe that the electric current has a brain.

A young woman was picking cherries off a rather tall cherry-tree. A young man stood underneath. The young woman was struck by lightning, and fell dead. This was in July, 1885.

In September, 1898, at Remaines, near Ramerupt (Aube), a certain M. Finot, an innkeeper, was standing on his doorstep looking out at a storm, when a flash of lightning followed by a thunderclap sent him flying

back into the hall. He remained unconscious for a time, and his sight was affected for ten hours. The extraordinary thing, however, in his case was that he had been a victim of rheumatism until then, and walked with difficulty and only with a stick, and that ever since this occurrence he has been able to do without the stick, and to pursue his avocations quite comfortably. He feels that he has no reason to regret his experience, though he is not anxious to go through anything of the kind again. This kind of electrical phenomenon might be catalogued under the title "Medicinal Lightning."

Now for a case of "Judicial Lightning."

On July 20, 1872, a negro named Norris was hanged in the State of Kentucky for having killed a mulatto, a fellow-workman of his. At the moment of his setting foot upon the scaffold, there was a terrible clap of thunder, and the condemned man was struck dead by lightning. The sheriff was so much moved by the occurrence that he resigned his office.

Let us wind up this little collection of strange cases with another occurrence reported from the United States.

An immense grange had been built by a man named Abner Millikan, an ardent republican, who adorned the front walls of his farm with portraits of MacKinley and Hobart. During a violent storm that broke out, the building was struck by lightning several

times, and it looked as though it were enveloped in great sheets of flame. Millikan, who had been at some distance from the spot, rushed thither much alarmed, and found to his relief that no damage had been done. The portraits alone had been destroyed, and—here is the strange detail—the lightning had traced the poilticians' features upon the wall.

Certainly lightning plays queer pranks. And I have said nothing yet of the photographs lightning sometimes takes.

Pranks they seem to us, but we may be sure there is some method in their mischievousness. It is the same with women. Women in their caprices are but obeying some law of nature. They are not so capricious as they seem.

These strange facts teach us, anyway, not for the first time, that our knowledge of the universe is still very incomplete, and that its study is worth following up in all its chapters.

We may be certain that electricity exercises a much more important influence in nature than is generally supposed, and that it plays a *rôle* in our own lives which is still practically unrecognized. In the oppression we feel before the coming of a storm, and the sense of relief we experience when it has passed, we have an instance of the way in which physical and moral influences are apt to blend or overlap.

CHAPTER II

ATMOSPHERIC ELECTRICITY AND STORM-CLOUDS

With such strange facts before us—facts the strangeness and diversity of which baffle all hypotheses and forbid all definite conclusions—we can but keep adding to our observations and accumulating other facts which may tend to elucidate the mystery. The terrible ravages caused every year by lightning make it necessary for us to find some means of preventing the recurrence of certain memorable catastrophes. It is only in the actual investigation of the phenomenon, in the study of all its smallest manifestations, that we can hope to discover the methods of the mysterious power.

From the earliest times mankind has devoted much thought to the subject. If we glance back towards past centuries we find that thunder and lightning have ever been regarded as a terrible agent of the will of the powers above.

The strongest and subtlest brains of antiquity, Anaxagoras, Aristotle, Seneca, were unable to form any kind of reasonable view regarding the fantastic

phenomena resulting from the force of nature and held so mysterious to us moderns. Thunder and lightning were generally believed by them to be due to emanations from the earth or to vapours contained in the air.

The Etruscans, who flourished fifteen hundred years before Christ, and who were much given to the study of nature, are said to have observed the tendency of lightning to make for points, but no theory upon the subject has come down to us from them.

Electricity for the ancients was an unplumbed ocean, whose slightest fluctuations affected them in ways they could not understand. In vain they appealed to their gods to help them to explain the enigma. Olympus turned a deaf ear to their prayers.

Their imagination exhausted itself in researches into the nature of such things as amber, in which they recognized the curious attribute of attraction and repulsion for objects of slight weight. The poets attributed it to the tears of Phaëton's sisters, lamenting over the dreams of Eridan. Certain naturalists regarded it as a kind of gum issuing from trees during the dry days. No one gave any thought to electricity, by whose subtle fluid the earth and everything upon it is penetrated and enveloped.

The superstitions connected with lightning would furnish forth material in themselves for a very curious volume of stories—half comic, half tragic.

With the Romans the fall of a thunderbolt was always taken as an omen. In the reign of Domitian, thunder was to be heard once so constantly during a period of eight months that the tyrant, frightened by the bombardment from on high, at last cried out in his terror: "Let the blow come, then, where it will!" The stroke fell upon the capitol, and upon the temple of the Flavian family, as well as upon the emperor's palace and the very room in which he slept. The inscription beneath the triumphal statue was even torn away by the tempest and thrown into a neighbouring garden.

Otto de Guérike, burgomaster of Magdeburg and inventor of the air-pump, was the first person to discover the means of producing the electric spark, about 1650. About the same time, Dr. Wall, while watching electricity being released from a roll of amber, noticed a spark and a sudden sharp report, suggestive of a minute flash of lightning, followed by a minute peal of thunder. The analogy was striking. This discovery opened out a new horizon to physicists, and almost immediately the feeble electric light produced by the hand of man came to be associated with the monstrous sheaves of fire let loose in space by unknown forces.

L'Abbé Nollet, considered in the France of his time as an oracle in regard to natural philosophy, expressed himself as follows upon this subject:—"If some one, after

comparing the phenomena, were to undertake to prove that thunder is in the hands of nature what electricity is in ours, that those electrical wonders with which we are now able to make so much play are petty imitations of those great lightning effects which frighten us; that both result from the same mechanism; and if he could make it evident that a cloud produced by the action of the winds, by heat, and by the mingling of exhalations, bears the same relation to a terrestrial object as an electrified body bears to an unelectrified body in its close proximity, I admit that the idea, if well worked out, would captivate me greatly; and, to work it out, how many plausible arguments there are at the disposal of a man who is properly versed in electricity!"

The invention of the Leyden jar in 1746, and Franklin's brilliant investigations, make these conjectures the more probable. Since then electricity has gone ahead and become one of the most important branches of modern natural philosophy.

When Franklin demonstrated that the air is in a permanent condition of electrification even when the sky is clear, people began to study not thunder alone but the general electrical state of the atmosphere. And ever since meteorological observatories have made it a practice to register every day the degree and nature of atmospheric electricity by the use of very ingenious instruments.

But the records obtained up till now leave us in doubt upon many points. The subject is still full of new surprises.

Whence come those masses of electricity which move about in the clouds, sometimes escaping from them in thunderclaps and causing such tremendous ravages upon this earth of ours? The evaporation of the sea is one of their principal causes.

The atmosphere is continually impregnated with electric effluvia which flow silently through the soil through the medium of all bodies, organized or not, attached to the earth's surface. Plants afford an especially welcome pathway to this fluid. The green leaves you see rustling in the wind are often being traversed by electrical currents, luckily harmless, of precisely the same nature as those of the deadly lightning. On the other hand, the earth itself emits a certain quantity of electricity, and it is from the attraction exerted by these two fluids upon each other that thunder comes into existence. To put it in another way, thunder is a sudden striking of a balance between two different masses of electricity.

Minute researches have established the fact that in ordinary conditions the terrestrial globe is charged with resinous, or negative electricity, while the atmosphere holds in suspension *vitrée*, or positive electricity.

In two words, our planet and its aerial envelope

are two great reservoirs of electricity, between which take place continual exchanges which play a *rôle* in the life of plants and animals complementary to that which is played by warmth and moisture.

The aurora borealis, which sometimes illumines, with a brilliancy as of fairyland, the darkness of night in the Arctic and all the regions of the North, finds its explanation in the same phenomenon. It also is a striking of a balance, silent but visible, between two opposing tensions of the atmosphere and the earth; thus the apparition of the aurora borealis in Sweden or Norway is accompanied by electric currents moving through the earth to a distance sufficiently great to cause the magnetic needle to record the occurrence in the Paris Observatory.

Indeed, the electricity which pervades the earth, silently and invisibly, is identical with that which moves in the heights of the enveloping atmosphere, and, whether it be positive or negative, its essential unity remains the same, these qualities serving only to indicate a point, more or less in common, between the different charges. The heights of the atmosphere are more powerfully electrified than the surface of the globe, and the degree of electricity increases in the atmosphere with the distance from the earth.

Atmospheric electricity undergoes, like warmth, and like atmospheric pressure, a double fluctuation, yearly

and daily, as well as accidental fluctuations more considerable than the regular ones. The maximum comes between six and seven in the morning in summer, and between ten and twelve in winter; the minimum comes between five and six in the afternoon in summer, and about three in the afternoon in winter. There is a second maximum at sunset, followed by a diminution during the night until sunrise. This fluctuation is connected with that of the hygrometric condition of the air. In the annual fluctuation the maximum comes in January, and the minimum in July; it is due to the great atmospherical circulation; the winter is the time when the equatorial currents are most active in our hemisphere, and when the aurora borealis is to be seen most often.

On the other hand, the water of oceans and rivers is continually evaporating under the influence of solar heat, and rises into the atmosphere, where it remains in the form of an invisible gaseous vapour. Soon it becomes cold again, and, in the process of condensation, transparent gaseous molecules become transformed into minute drops, which accumulate into a cloud.

Generally speaking, clouds are, like the atmosphere, charged with positive electricity. Sometimes, however, there are negative clouds. You may frequently see, on the summits of mountains, clouds which seem to cling to the peaks for a while, as though drawn to them by

some force of attraction, and then move away to follow the general direction of the winds. It often happens that in this case the clouds have lost their positive electricity in thus coming in contact with the mountains, and have derived from them in its place the negative electricity which, instead of holding them, has a tendency to drive them off. A mass of clouds lying between the negative earth and a mass of positive clouds above is almost neutral; the positive electricity accumulates towards its lower surface, and the first drops of rain will make it disappear. This mass will, from that moment, become like the surface of the soil —that is to say, it will become negative under the influence of the mass above it, endowed with a strong positive tendency.

The cloud remains suspended in space until the moment when, under the influence of the ambient medium, it dissolves in rain.

The causes of the instability of clouds are very numerous. My readers are aware that the atmosphere is being constantly agitated by vast currents which pass from the equator to the poles, and from which the different winds result.

The clouds take part in this universal whirl of atmospheric waves. Transported from one point to another—often far beyond the region where they came into existence—subjected to every vicissitude of

atmosphere, and blown about by contrary currents, they follow the gigantic movements which take the form sometimes of cyclones and tempests.

Under the influence of warmth, and probably also by its transformation, these movements engender great masses of electricity, and presently, when the clouds have become saturated with it, the electricity breaks out, and there is a thunderstorm.

The electric fluid, escaped from the cloud in which it has been imprisoned, flies to unite itself, either with the negative electricity stored in the surface of the earth, or else with the electricity in other neighbouring clouds. Almost always the cloud torn open by the electric discharge dissolves in rain or hail.

Thus a storm is the outcome of violent movements produced by the force of electricity when this has reached its maximum of intensity. Thunderstorms are generally heralded by certain premonitory signs. The barometer goes down steadily. The air, calm and heavy, is pervaded by a bitter sulphurous odour. The heat is stifling. An abnormal silence reigns over the land. All this has a remarkable effect upon certain organisms, and produces nervous complaints, a buzzing in the ears, a sense of painful oppression, a sort of good-for-nothingness that we combat in vain.

In most cases storms come to us in France ready made, so to speak, from the sea, borne in by the

currents from the south-west; they are the off-shoots of the cyclones, and are born in the tropics, moving in lines from the south-west to the north-east. Ordinarily they lose part of their strength *en route* and come to an end suddenly with us.

There are, of course, home-made storms also, so to speak, especially in France during our hot summers, when the sun is shining all the day, and thus promoting the rapid evaporation of our seas and rivers.

The air is charged with a heavy mist which veils the horizon; the barometer is going down, the thermometer going up. The sun looks leaden though there are no clouds. When it approaches the meridian and its rays are most scorching, columns of vapour ascend and become condensed into the light clouds termed *cirri*. At the end of some hours these clouds become attracted to each other, descend a little, and become grouped together into what look like great masses of cotton-wool. These are termed *cumuli*. Presently a small grey cloud joins the others. It looks innocent and harmless, but very often this is the beginning of the battle. First there ensues, perhaps, a discharge or two of lightning without casualties, but soon the bombardment becomes general, and long blinding fusillades flash through space. The heavens, darkened over, seem to have sunk quite low, and to have become a great black mass, from which the

lightning escapes in sudden jets. Rain and hail pelt down upon the earth to an accompaniment of the rumbling of thunder. Confusion has fallen upon the entire universe.

Then, finally, the fight comes to a close. The clouds disperse and allow us to see once again a wide expanse of sunlit blue. The birds, their hearts freed again from terror, begin to sing again. Flowers and foliage and soil, refreshed by the rain, give out sweet perfumes. An immense joy takes the place of the sense of melancholy and oppression. It is good to see the sun again! Alas, though, there are grim realities to be faced presently. The hailstones have destroyed the crops and begotten famine—the lightning has sown death and plunged whole families into mourning. It is with these misfortunes before us that we make up our minds to do what in us lies to diminish the destructiveness of this terrible force.

How are storm-clouds to be detected?

Generally speaking, their shape is very clearly defined, and they have a look of solidity about them.

Their lower surface is often unbroken, presenting a level plain from which there rise huge ragged protuberances like great plumes. Sometimes, on the other hand, they have great projections underneath, trailing quite near the ground.

Storm-clouds move generally in large numbers,

and are generally composed of two separate masses, differently electrified—the lower one giving out negative electricity, the higher positive electricity. The flashes of lightning occur generally between these two masses, though also, less frequently, between the lower mass and the earth.

It may be said that, generally speaking, storms are the result of the meeting of two masses of clouds differently electrified.

For long, physicists refused to admit the validity of any other theory, and combated in particular the idea that lightning could issue from a single isolated cloud.

This has, however, been established now as a fact, and in such cases the flashes have always, of course, taken place between the cloud and the earth.

Marcorelle, of Toulouse, reports that on September 12, 1747, the sky being then pure and cloudless but for one round speck, there was suddenly a thunder-clap and a flash which killed a woman on the spot, burning her breast but doing no damage to her clothes.

Here is another interesting case. Two priests of the Cathedral of Lombey, who were standing in the area of their chapter-house, busy winnowing, saw a small cloud approaching them little by little. When it was immediately above them a flash of lightning broke out and struck a tree just beside them,

splitting it from top to bottom. They heard no thunderclap. The weather was quite fine. There was no wind, and this was the only cloud in the sky.

Storms are far more prevalent in some countries than in others. According to Pliny, thunder was unknown in Egypt, and, according to Plutarch, in Abyssinia. This could not be said now, however, perhaps because these lands have grown unworthy of their exemption. It might be said, however, of Peru, whose pure and limpid skies are never troubled by tempest. *Jupiter tonans* must be a myth indeed to a people who know nothing of thunderclaps or wet days.

Storms diminish in number in high latitudes, but there are local conditions which affect their distribution. Then they are particularly frequent in countries that are thickly wooded and in mountainous districts.

Arago came to the conclusion, after a considerable number of observations, that, out in the open sea or among islands, there is no thunder in the north beyond the 75th degree of latitude. This is not absolutely so, but it is a fact that storms are very much rarer in the polar regions. They become more and more frequent towards the equator, and are very numerous in the tropics.

On either side of the equator storms come year after year with remarkable regularity in the wet season, and at the time of the monsoons.

At Guadeloupe and Martinique there is never any thunder in December, January, February, or March.

In temperate climates there are scarcely any storms in winter; they begin in the spring, and attain their maximum of intensity in the heat of summer.

In Italy there are thunderstorms at almost all times of the year.

In Greece they come chiefly in spring and autumn.

It is noticeable that in all latitudes they come most often in the afternoon.

CHAPTER III

THE FLASH AND THE SOUND

THE Romans attributed a mysterious influence to each manifestation of electricity. They divided lightning into individual and family lightning, lightning of advice, monitory, explanatory, expostulatory, confirmatory, auxiliary, disagreeable, perfidious, pestiferous, menacing, murderous, etc., etc.

They adapted it to every taste and circumstance, but modern science has come to put order into this Capharnaum.

When a cloud is superabundantly charged with electricity, this electricity, which is compressed in the cloudy envelope, tries to escape in order to join the electricity accumulated either in another cloud or on the ground. An electric deflagration ensues, and a long ignited dart precipitates itself into space, showing us on a large scale what our experience of physics has taught us in a small way in our laboratories. This luminous and often dazzling trail constitutes lightning.

Lightning is not always the same, and in order to

classify the different forms it takes more easily, it can be divided into three groups — diffused lightning, linear lightning, and fireballs. This last is the most curious of the three. The variety and eccentricity of fireballs are celebrated in the history of lightning, and I propose to devote the following chapter to their vagaries.

Diffused lightning is the commonest of all. You can count hundreds of flashes on a stormy night. Occasionally they succeed one another with such rapidity that the sky is momentarily entirely illumined with a fantastic brightness. At these times great sombre clouds can be seen surging from the darkness of the night, to shine suddenly with an ephemeral brightness of a diffused red, blue, or violet tinge. Their irregular shapes, with their jagged edges of light, are visible against the dark background of the heavens, and the thunder growls monotonously. Whether the exchange of electricity is produced on a vast stretch between two rows of clouds, or whether it is manifested by a long thin spark launched like an arrow and veiled by the curtain of clouds, all that can be seen is a strange light, vague, diaphanous, instantaneous, which sometimes spreads itself like a sheet of fire all over the horizon.

It is diffused lightning which gives us the finest storm effects on those heavy summer evenings when the air is breathless and saturated with electricity.

Suddenly the clouds are illumined, nebulous veils of light on which can be seen, in sombre fantastic, fugitive vision, the outlines of the trees, houses, and other landmarks. Then, all at once, heaven and earth fall back into a darkness deeper than before, owing to the contrast.

Linear lightning is more terrible. It is regarded by astronomers as the most perfect form of destructive lightning. It is a strong flash—a thin trail of light—very clear, and extraordinarily rapid, which shoots from an electric cloud to the earth, or from one cloud to another.

Like a supple and undulating serpent of fire, it twists itself luminously into space, spreading itself menacingly in the heavens with its long spirals of light.

Sometimes—in a hurry, no doubt, to reach its prey—it effects its passage in a straight line, but as a rule it follows a sinuous track, and forms itself into a zigzag at an obtuse angle. The different forms which this lightning takes are no doubt attributable to various causes. One of the chief of these seems to be the unequal distribution of humidity in the air, which renders it a more or less good conductor. In fact, fulminic matter is strongly attracted towards damp regions, and goes quickly from one point to another, guided in its chosen way by the hygrometrical

conditions of the atmosphere; and it is these constant changes of direction which determine the meanderings of its course. Thus the lightning would trace a sort of plan of the hygrometrical state of the air for a certain portion of the atmosphere. For it, the short road is hardly ever the straight line.

On the other hand, the variability of the overloading of electricity has something to say to the form it takes.

Sometimes lightning forms itself into two or three branches, and becomes forked lightning. Or it even divides itself into a number of points from a principal branch, out of which a great many sparks burst forth.

These incandescent sheaves move through space with extraordinary agility. It has not been possible to measure their speed with absolute accuracy, but their rapidity is such that their transit appears to be instantaneous. The latest researches seem to have proved that their speed is superior to that of light, which is 300,000 kilometres a second.

Lightning is not always of a dazzling whiteness, it is often yellow, red, blue, violet, or green. Its colour depends on the quantity of the electricity thrown on the atmosphere by the discharge; on the density of the air at the time of the passage of the ignited matter; on its hygrometrical state, and on the substances which it contains during suspension.

It has been remarked in the study of physics that the electric spark is white in the open air, but that it gets a violet tinge in the vacuum of a pneumatic machine.

This proves that violet lightning comes from the far-off regions of the atmosphere. It traverses a bed of rarified air, and shows the great height of the storm-clouds from which it emanates.

The fulminating spark is so fugitive that it is difficult to form an idea of its length. One could easily take it to be a yard or so long, so illusory and deceptive are our impressions. As a matter of fact, it is proved that flashes of lightning cover a distance of several kilometres.

There are various methods to which one can have recourse in these scientific researches. The first, which gives the length of horizontal lightning, is based on a minute comparison between the trajectory described by the meteor and the known distance of the terrestrial points between which it travels. In order to gauge the extent of vertical lightning, you must estimate approximately the height of the clouds from which it comes, based on the irregularities of the earth of which the height is known.

But there is a still simpler method for approximate measurement within the reach of every one. It consists in multiplying 337 (the number of yards traversed

by sound in a second) by the number of seconds during which the thunder lasts.

These methods all give the same result, and prove that lightning is often 1, 5, and 10 kilometres in length. The greatest length proved up to the present has been 18 kilometres. When one thinks of the instantaneousness of these flashes, one marvels at their incomparable agility, and we can only be lost in admiration of the magic force of the heavenly sling, which is capable of hurling these whole rivers of fire to roll in their sinuous course right through space, and in a space of time almost inappreciable to our senses.

Yet, in spite of the extreme rapidity of the lightning, it has been possible to determine that these meteors do not last the thousandth part of a second. To prove this, we take a circle of cardboard, divided from the middle into black and white sections. This circle can be turned like a wheel almost as quickly as one can wish. We know that luminous impressions remain on the retina the tenth part of a second; thus, if we imitate the childish game of turning a lighted coal—if the turn is made in the tenth of a second, each successive position of the coal remaining impressed on the retina for the same length of time—we have a continuous circle. In turning our cardboard wheel with the black and white spokes, if each spoke

passes before our eyes in less than the tenth of a second, we can no longer distinguish between the sections, but can only see a grey circle. But we can make it rotate a hundred turns or more in a second; this being done, if we continue to observe the circle, we can no longer see the lines, they succeed each other more quickly in our eyes than the impression they produce. But if the circle turns before us in the darkness, and it is suddenly lighted up and as suddenly darkened, the impression produced on our eyes by each of the sections would last less than the tenth of a second, and the circle would appear to us as if it were stationary. In applying a calculated rotation to this contrivance, Charles Wheatstone has proved that some lightning does not last the thousandth part of a second. This measure is probably a minimum; in the majority of cases the duration of lightning is longer than this.

Often during the hot, transparent summer nights, we see a considerable number of flashes, which furrow the firmament with their gentle, bluish light. These fugitive gleams remind us in the sky of the will-o'-the-wisps, which come forth silently from marshy ground. The atmosphere is pure; there are no apparent traces of a storm, and yet the sky is glistening with thousands of small flames. The flashes succeed one another almost without interruption. These

electric sparks are known as heat-lightning, but this is quite inaccurate, and has no meaning in the language of modern science.

In a great number of cases an astronomer would be able to discover certain characteristic signs indicating that a storm is taking place under the horizon at a very great distance from the point of observation. It is only at the moment when the sky is lighted up that one can see the ridge of clouds lying low on the horizon. At other times there is no sign of a storm, as far as the eye can see. The atmosphere is quite clear, and yet the sky is swept with a number of electric flashes. But afterwards you hear that a violent storm has devastated the region over which the gleams have appeared, and that it is to this that they are attributable. They are only reflected lights.

A sailor tells us that once when he was out at sea, more than 100 kilometres from Lima, he saw a number of bright flashes, without any thunder, to the east and north-east of the horizon. The weather was perfect, and the sky absolutely serene. Now we know that storms, and the electric phenomena which they produce, are unknown upon that coast; but this immunity does not extend for more than 100 kilometres to the interior of this country, so that this lightning which was observed at sea, 100 kilometres

from the shore, must have taken place more than 200 kilometres away.

One of our correspondents, M. Soleyre of Constantine, sent us word, in 1899, of an interesting case of lightning without thunder.

"In August," he says, "I noticed it in the valley of the Arve above Salambes; when I came back to Algiers I saw it again on September 16, and on October 19.

"It was not sheet lightning, but ordinary lightning concentrated in very thin lines. This lasted long, and was very near. Another thing, there was no hail. This is not very rare in Algiers."

On September 1, 1901, I happened to be in Geneva at about 6 p.m. The weather was heavy but very fine. I noticed a good deal of lightning on the south-west of the horizon. It went on almost without interruption above the Savoy Alps. Each flash illuminated at the same time the ridge of the mountains and the fringed edge of the great sombre clouds lying low on the horizon. This lightning was silent; the noise of the thunder did not reach Geneva. The next day I learnt that a terrible storm had devastated the neighbourhood of Chambery and Aix-les-Bains.

Moreover, apart from storms, there have been other records of this lighting up of the sky being observed at great distances.

Thus, in 1803, a service of luminous communications was established on Mount Brocken in the Hartz Mountains in order to determine the differences of longitude. The combustion of 180 to 200 grammes of powder, burnt in the open air, for each of the signals, produced a light which was observed by astronomers stationed on Mount Kenlenberg, although they were 240 kilometres from Brocken, which is itself invisible from Kenlenberg.

On certain fête-days, July 14, for example, when the principal monuments in Paris are illuminated, at a distance of 20 and 30 kilometres we can see a sort of luminous vapour which floats above the town and reflects the lights of the boulevards, although the lights themselves are invisible from the point of observation.

Here is another example which any Parisian can verify: the captive balloon of the Aërodrome at Porte-Maillot, which soars some hundreds of yards above Paris during the spring and summer, as seen from the dark paths of the Bois de Boulogne, appears against the azure of the sky like a magnificent globe bathed in light, resembling an enormous moon. Well, this gentle, pale light is only the reflection of the lights of Paris which are invisible from the Bois de Boulogne.

The earth and all the planets which are dark in themselves, shine in space lighted up by the sun.

The silent lightning which flashes in the sky is only the reflection of a distant storm. Whether on account of the spherical shape of the earth or on account of the irregularities of the land, the clouds are invisible, but the effluvium which escapes from them can be seen at a great distance.

These poetic and ephemeral flames which glide through the sky, appeal to the imagination of the dreamer, and yet they are quite as terrible as the flashes which are accompanied by thunder. If the noise which accompanies these is not perceptible, it is because the sound of the thunder does not carry far, and has been lost in space before reaching us.

It is the same with the silent lightning which gleams in a stormy sky. This phenomenon is particularly frequent in the Antilles. Either the storm breaks too far from the observer, or the discharge has taken place between two beds of clouds, the lower of which intercepts the waves of sound without preventing the escape of the electric spark, and the thunder is not heard.

As a rule we imagine that lightning always descends, that it comes to us from the higher celestial regions to be lost in the common reservoir. But this is quite inaccurate. Lightning sometimes ascends. Sometimes it descends and reascends. That is to say, after it reaches the ground, either there is no attraction there,

or a stronger force draws it back to the aërial regions, and it flies back to the clouds whence it came.

As a rule we only fear the direct lightning. This is a great mistake. There are many cases of lightning striking from a distance.

For example, at the end of May, 1866, an English coastguard was making his rounds on the coast of one of the Shetland Isles, when a flash of lightning passed near him, striking a great rock. The unfortunate man was completely blinded, and plunged into darkness thus suddenly, he would inevitably have fallen down an abyss, if his companions, attracted by his cries, had not come to the rescue and taken him home.

Here is another case :—

On September 24, 1826, a terrible storm burst over Versailles, accompanied by a great deal of thunder and lightning. At the moment when the lightning struck Galli's farm, an old man who was in a street in Versailles, at a distance of two kilometres from the farm, suddenly felt a violent shock, accompanied by a feeling of oppression and giddiness and a semi-paralysis of the tongue and the whole of his left side. Next morning this had passed away, but in the evening at the same time as the shock had occurred, he felt similar sensations of fainting, and it was the same to the end of the week. It would be well to remark here that at the moment of the accident, M. B——

happened to be near the wall of a house, not far from the metallic tube which conducted the rain-water into the level of the pavement.

The following phenomenon, to which we have already alluded, is no less curious:—

On July 22, 1868, at about 7 o'clock in the evening, at Gien-sur-Cure (Nièvre), the thunder had been growling violently for some time, when all of a sudden the lightning struck a thatched house, which it set on fire. At the same time a woman who was in a house ten yards away, felt a shock, and saw the tiled floor rise beneath her. Her two sabots were broken on her feet, and a bottle of Holy Water with which she was blessing the house was broken in her hand, only the neck remained in her fingers. She herself suffered nothing but the shock. Nineteen of the tiles were flung in all directions.

Here is another very remarkable case of *ascending lightning*, published in the *Comptes Rendus* of the Academie des Sciences:—

At Porto-Alegre, on June 9, 1870, at 2 a.m., during a violent storm, on the property of M. Laranja e Oliveira, at Brazil, a servant was entering the house; he was about ten yards away, when a flash of lightning illuminated it; at the same moment he felt a great tingling in the flesh of his feet, then in his legs, then all over his body, and finally in his head, on which the

hair stood on end to such an extent that *he was obliged to hold his hat on* in order to prevent its falling off. At the same time, a white flame burst from the ground about two yards in front of him, accompanied by a shower of sparks. Terrified by such a phenomenon, which he attributed to souls from another world, he thought he was petrified to the spot; finally, he ran away. Anything metallic which he had about him at the time of this occurrence became magnetized. A key which was in his pocket remained magnetic for two days.

Thus, as well as the ordinary fulguration, in which the lightning (which we imagine descends from the clouds) acts directly on the body, and the lightning which strikes indirectly, there are other electric shocks which can be experienced by men and animals. Notable among these is the *striking from the earth*, commonly known as *choc de retour*, and which is in reality only an instance of the ascending current, or of lightning striking from a distance. We must also describe the striking *by a man who has been struck.*

The Abbé Richard, in his *Histoire de l'Air*, tells the following story:—

In the neighbourhood of the village of Rumigny, in Picardy, on August 20, 1769, at six o'clock in the morning, there was a sudden irruption of fulminating matter from the bosom of the earth in such quantities

as to produce the most violent results. The sky was cloudy, and looked like a storm. A young farmer and his wife were following, at some distance, a vehicle drawn by four horses. Suddenly the driver of this, *without seeing the lightning or hearing the thunder*, was thrown to the earth. His four horses were stretched dead on the ground near the carriage. There was a *smoking hole* in the ground, from which the effluvium came forth and killed the young man and his wife at ten paces off and separated from each other by twenty paces. The current also knocked down, at a hundred paces, the father of the young man in the same fashion as it had done the driver, but without injuring one or the other.

The bodies showed no signs of a wound, only a considerable swelling and a great deformity of the features. The woman, who was young and pretty, became hideous; the whole of her body as well as that of her husband was absolutely yellow. The four horses had their intestines drawn from their bodies. They were all thrown on the same side. The man's hat was pierced and his hair burnt, but he had no bruise on his head.

This account, in which we must not be surprised to find the ideas and language of the time (let us observe in passing that the man who was struck did not hear the thunder, and had not even time to see the lightning

of which he was the victim)—this account, I say, gives us an instance of ascending lightning. Here is another.

The traveller Brydone gives the following example, which he himself observed:—

On July 19, 1785, a storm burst near Coldstream between 12 and 1 a.m. A woman who was cutting hay on the banks of the Tweed *fell backwards.* She at once called to her companions, and said she had just received a violent blow on her foot for which she could in no way account. At the time there was no thunder or lightning in the sky. The shepherd of a farm at Lennel Hill saw a sheep fall near him, which a few minutes before appeared to be in perfect health; he found it stone dead. The storm then appeared very far off. Two carts laden with coal, and each driven by a young driver seated on a small seat in front, crossed over the Tweed. They had just climbed a small hill near the banks of this river when they heard a great detonation round about, similar to that which would be produced by the discharge of several guns. At the same instant the driver of the second cart saw the first, with his companion and the two horses, fall to the ground. *The driver and horses were stone dead. The ground was pierced with three circular holes at the very spot where the wheels had touched it when the accident happened.* Half an hour after this event the holes emitted an odour which Brydone compared to

that of ether. The two circular iron bands which covered the felloes of the wheels showed evident signs of fusion in the two spots which rested on the ground at the moment of the detonation, and in no other place. The skin of the horses had been burnt, particularly about the legs and under the stomach. The body of the driver had marks of burning here and there. His clothes, his shirt, and, above all, his hat, were reduced to shreds, and gave out a strong smell.

Orioli gives an example of two men who were surprised by a violent storm near the village of Benvenide. They lay down on the ground to let the meteor pass. Some moments later one of them got up feeling very tired, but the other was dead. The bones of the latter were so soft that it was easy to bend them; his whole body was of the consistency of paste. The tongue had been torn from the roots, and no one knew what had become of it.

Now, just as the earth can strike, so can the human body become fulminating and act like lightning. After having been struck, it can effectively acquire the power to strike in its turn.

For instance, on June 30, 1854, a man named Barri was killed by lightning near the Jardin des Plantes, in Paris, and his body lay for some time exposed to a beating rain. After the storm had passed, two soldiers from the neighbouring guard-house tried to remove

the body, and each received a violent blow when they touched it. They got off with a shock, perhaps because the body had been drenched with rain, which acted as a conductor to the electricity, and thus it had had time to lose a part of the fluid.

What a mysterious world is that of atmospheric electricity! It is truly the New World for the scientific mind—a mine, fruitful in unknown and even unsuspected marvels, which is perpetually disclosing its riches for our admiration.

One of our most valued collaborators in our researches on the nature of lightning is photography. Faithfully and unhesitatingly it registers an indestructible document of the fugitive lightning, which imprints itself on the sensitized plate, and the astronomer can afterwards examine the smallest details of the sudden apparition comfortably and at his leisure. We have already a considerable number of plates of the outline of the lightning in flight. An examination of these electric pictures is very interesting.

Who knows whether, later on, when phonography is brought to perfection, it will not also register the noisy accompaniment to the electric flash? Then, with the help of the cinematograph, we could have dramatic representations of sensational storms. While the photograph unrolls all the phases of the lightning, from its emerging from the cloud to its fall to earth,

before the gaze of the spectators, the phonograph will repeat the sonorous accents of the terrorizing voice of thunder.

Thunder, as all the world knows, is the noise which accompanies lightning. It is produced when a change of electricity—a neutralization—takes place between two points more or less distant. The causes which provoke it are still somewhat of a mystery.

The luminous rocket which flings itself precipitately from a cloud saturated with electricity, spreads itself like a trail of flames in the atmosphere where an infinity of invisible molecules are floating; these it repels. The passage of this whirlwind of fire in a centre which is greatly compressed produces a momentary void into which the surrounding air at once rushes, and it is the same all the way along the route followed by lightning.

In all probability the equilibrium of the atmosphere, which is momentarily disturbed by the intrusion of the ignited matter, hastily re-establishes itself by a rush of the air which the lightning has ejected, and which is swallowed up with a crash in the opening which has been made. It is, on a large scale, a similar phenomenon to that which is produced by opening a case which has been hermetically sealed. The air rushing in makes a dull noise.

Pouillet objects to this very natural explanation on the ground that the flight of a cannon-ball ought to

produce a similar noise. But this objection errs in its basis, because, as regards velocity, a cannon-ball is as a tortoise as compared with the arrow of lightning, and as regards size, who can compare a few grammes of powder to the torrents of fire launched into space by the prodigious force of electricity?

The lightning discharge produces a violent concussion in the cloud, and very often a shower of rain immediately follows it. The electric conditions of the different clouds which make a storm being separately liable the one to the other, the discharge of one must lead to that of several others more or less distant. In all cases the noise is caused by the expansion of the air where a more or less partial void has been made. It is the same with fire-arms, *crève-vessie*, etc.

One of the chief characteristics of thunder is the rolling, which is often prolonged, and reverberates on the sides of steep mountains. This voice, with its lugubrious tone, becomes grave and sometimes sinister in the revolution of space—this voice, celestial and infernal, seems to momentarily dominate the world, while the clouds are enveloped with a thousand diabolical flames. Sometimes it rings in the air with fierce calls, at others it spreads itself in dull, languorous complaints.

Nevertheless, the intenseness of thunder undergoes a thousand fluctuations, and presents astonishing

variations. Generally it strikes and frightens, but the curious thing is that, for the ear, in reality it is less strong than the crinkling noise of a piece of paper torn close to it.

Often, too, it may be compared to the discharge of fire-arms, a pistol or a cannon.

Thus, when the lightning penetrated Volney's apartments at Naples, the people present, among whom was Saussure, had the impression of a pistol-shot in the next room.

There is a case given of M. and Mme. Boddington, who were seated on the back seat of their coach in order to enjoy the view of the country, and had given the inside seats to two servants. Suddenly there was a flash of lightning, which struck M. and Mme. Boddington and flung the postillion to a great distance. The servants were untouched, and escaped with a fright. When they got over their terror, one of them said that a very brilliant flash of lightning had been immediately followed by a noise similar to that of a heavily charged musket. He thought some one had shot the horses. His fright had stunned him so that he hardly knew what had happened.

At other times thunder is accompanied by a whistling noise, but as a rule it is the rolling which predominates.

We ask ourselves to what it is due that this rolling

lasts so long. There are several causes. The first is due to the length of lightning and the difference in speed between sound and light. Let us suppose, for example, a flash of lightning, AE, 11,000 metres long. The observer stationed at O, underneath extremity E of the lightning (which is one kilometre high), will see the lightning in its full length in one indivisible instant. The sound will form itself also at the same

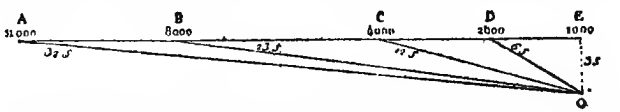
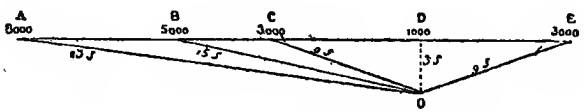


DIAGRAM EXPLAINING THE DURATION OF THE SOUND OF THUNDER.

instant all along the line of lightning, but the sound-waves will only reach the ear of the observer at different times. That which starts at point E, the nearest, will arrive in 3 seconds, sound travelling about 337 metres a second. That which is formed at the same moment at point D, 2000 yards from point O, will take double the time to arrive. That which comes from point C will not arrive for 12 seconds. The sound formed at B will not arrive until the time necessary to cover 8 kilometres—that is to say, not for 23 seconds—and the sound formed at A will only reach after 32 seconds. Thus the rolling will have lasted more than half a minute from start to finish.

And if, which is very often the case, the astronomer

is not exactly under one of the extremities of the lightning, but at some other point in its course, he first hears a clap, then an increased noise, then a diminution. In fact, in this case, the sound which leaves point D just overhead, which is 1000 metres off, arrives alone in 3 seconds, but the sounds formed from D to E on one side, and from C to D on the other, arrive at the same time, having joined each other,



COMMENCEMENT, AUGMENTATION, AND DIMINUTION OF THE INTENSITY OF THUNDER.

taking 9 seconds, which is the necessary time to come from 1000 to 3000 metres. The sounds beyond C arrive and depart according to distance, as in the preceding example, and the thunder has lasted 23 seconds instead of 32 seconds.

I must add that lightning is never straight, but always crooked.

The length of time the thunder rolls has nothing to do with the distance of the cloud where the phenomenon begins. It is proportionate to the length of the lightning with which it is associated. The rolling is often still more prolonged by a succession of small discharges, which follow each other very rapidly between

the stormy clouds; by the zigzags and ramifications of the lightning caused by the hygrometrical diversity of the different beds of air; by the echoes repeated by the mountains, the earth, the water, and the clouds themselves—to all which must be added also the interferences caused by the encounter of the different systems of sound-waves.

Its duration is extremely variable, however; it rarely exceeds 30 seconds, though the noise may sometimes seem to last much longer, so that an observation of this kind may have any value—one must take into consideration the echo, and isolate a single clap from the series of discharges which take place in the bosom of the storm. The longest verified duration of a single discharge is 45 seconds. That is tremendous if we think of the instantaneousness of the lightning, and reflect that the flash and the sound are produced in reality at the same moment, that they are dependent the one on the other, and that in their various manifestations there is only the difference of motion.

Sound moves like a tortoise behind the swift lightning, whose vibrations spread in the air with inconceivable rapidity.

Hence these 45 seconds correspond to a flash of lightning more than 15 kilometres in length, but we know that there are even longer ones.

I have already said that we can calculate the

distance of the celestial cannon from which the fulminating discharge comes by counting the number of seconds which separate the apparition of the lightning from the first growls of the thunder. Thus the longest interval that has been proved between the appearance of the lightning and the noise it produces is 24 kilometres. This, however, is a maximum.

Numerous observations have proved that thunder is never heard beyond 20 or perhaps 25 kilometres. Lightning pierces the cloudy veil, but the voice of thunder does not carry so far. In this the great Jupiter shows himself inferior to the ingenuity of human pigmies, whose destructive and barbarous art has been able to invent infernal machines the noise of which can be heard much further.

Cannon can easily be heard at a distance of 40 kilometres. Sometimes, in sieges and big battles the cannonades can be heard muttering lugubriously more than 100 kilometres away.

During the siege of Paris, Krupp's cannon—that most expeditious of all vehicles of civilization in the eyes of the statesmen of this planet!—could be heard as far as Dieppe, 140 kilometres away, during the nights when they were bombarding. The cannonade of March 30, 1814, which crowned the First Empire, as it crowned the Second, was heard between Lisieux and Caen, a distance of 175 kilometres. Arago even

alleges that the cannon at Waterloo could be heard as far as Creil, which is 200 kilometres away. Thus man's thunder can be heard at a greater distance than that of nature. It is true that it is incomparably more vicious, and that it has a great many more victims.

In its natural state, if we might explain it thus—left to itself—it comes directly to us from the high regions of the atmosphere, and is the most terrible of aërial messengers—a subtle messenger, malicious and violent, it is the terror of the human race. But ruled by the genius of man, it becomes a powerful agent towards modern civilization, and we cannot sufficiently admire its many advantages.

If we could tame lightning and guide it safely, its services would probably become innumerable. Lightning as man's right hand! Why not? Was it not the auxiliary of the gods in the dark ages? To-day, is it not regarded by astronomers as one of the most important forces of nature? Why should it not be the collaborator of man's intelligence to-morrow?

CHAPTER IV

FIREBALLS

HERE we penetrate into what is, perhaps, the most mysterious, and certainly the least understood domain of thunder and lightning.

Among all the electrical phenomena to be observed in the atmosphere, there is nothing stranger than those fireballs of which we have already spoken, and which in form and size recall the electric lights in our Paris boulevards. Curious the contrast between electricity tamed and civilized and electricity running wild! Between the arc lights fulfilling their peaceful and useful function as substitutes for the sun, and these dread engines of destruction sowing death and havoc!

It is not long since the existence of these fireballs has been acknowledged by scientists as an actual fact. Until quite recent times they were regarded as the figment of excited imaginations, and wise men smiled at the wild stories of their ravages. Their reality has now been established, however, beyond the possibility of doubt.

In shape they are not always quite spherical, though this is their normal appearance; and although their contours are usually clearly defined, they are sometimes encircled by a kind of luminous vapour, such as we often see encircling the moon. Sometimes they are furnished with a red flame like a fuse that has been lit. Sometimes their course is simply that of a falling star. Sometimes they leave behind them a luminous trail which remains visible long after they themselves have disappeared. They have been described as looking like a crouching kitten, an iron bar, a large orange—so harmless apparently, that you were tempted to put out your hand to catch it. There is record of one being seen as large as a millstone.

One remarkable thing about them is the slowness with which they move, and which sometimes enables their course to be watched for several minutes. In our first chapter we gave several instances of the occurrence of fireballs. Let us look at some more. Here is one taken from Arago's learned treatise upon thunder. The record is from the pen of Batti, a marine painter in the service of the Empress of Austria and resident at Milan.

"In the month of June, 1841, I was staying at the Hôtel de l'Agnello in a room on the second floor, overlooking the Corso dei Servi. It was about six in the afternoon. The rain was coming down in torrents, and

the darkest rooms were lit up by the lightning flashes better than our rooms generally are by gas. Thunder broke out every now and again with appalling violence. The windows of the houses were closed, and the streets were deserted, for, as I have said, there was a steady downpour, and the main road was turned into a torrent. I was sitting quietly smoking, and looking out at the rain, which an occasional ray of sunlight set flashing like threads of gold, when I suddenly heard voices in the street calling out 'Guarda, guarda!'—'Look, look!' and at the same moment a clatter of hob-nailed boots. After half an hour of absolute silence, this noise attracted my attention. I ran to the window, and looking to the right, in the direction of the clamour, I saw a fireball making its way down the middle of the road on a level with my window, in a noticeably oblique direction, not horizontally. Eight or ten persons, continuing to call out 'Guarda, guarda!' kept pace with it, walking down the street, stepping out quickly. The meteor passed my window, and I had to turn to the left to see what would be the end of its caprice. After a moment, fearing to lose sight of it behind some houses which jutted out beyond my hotel, I went quickly downstairs and into the street, and was in time to see it again and to join those who were following its course. It was still going slowly, but it was now higher up, and was still ascending—so

much so that after a few minutes it hit the cross upon the clock tower of the Chiesa dei Servi and disappeared. Its disappearance was accompanied by a dull report like that of a big cannon twenty miles away when the wind carries the sound.

"To give an idea of the size and colour of this globe of fire, I can only compare it to the appearance of the moon as one may see it sometimes rising above the Alps on a clear night in winter, and as I myself have seen it at Innsbrück—that is to say, of a reddish yellow, with patches on it almost of red. The difference was that you could not see the contours of the meteor distinctly as you could the moon, and that it seemed to be enveloped in a luminous atmosphere of indefinite extent."

This fireball was an innocuous one. We may take next, by way of contrast, the case of one which wreaked terrible damage and loss of life.

On July 27, 1789, at about three o'clock in the afternoon, a fireball of about the size of a cannon-ball, fell in a great hall at Feltri (Marche Trevisane) in which six hundred people were seated, wounded seventy and killed ten, putting out all the lights.

On July 11, 1809, about eleven o'clock in the morning, a fireball penetrated into the church of Chateauneuf-les-Moustiers (Basses-Alpes) just as the bell was ringing and a large congregation had taken

their seats. Nine persons were killed on the spot and eighty-two others were wounded. All the dogs that had got into the church were killed. A woman who was in a hut on a neighbouring hill saw three fireballs descend that day, and made sure they would reduce the village to ashes.

Müsschenbroek recounts the following incident which took place at Solingen in 1711. M. Pyl, the Pastor at Duytsbourg, was preaching one Sunday, when in the middle of a storm a fireball fell into the church through the clock tower and exploded. The sanctuary was set on fire and became thick with smoke. Three persons were killed and more than a hundred were wounded.

From the *Bulletin* of the Société Astronomique de France the following narrative contributed to it by Mlle. de Soubbotine, a member of this society, has been taken:—

"A terrible storm broke out at Ouralsk on May 22, 1901. It was a *fête* day and the streets were thronged with people. Towards five in the afternoon some young men and girls, twenty-one in all, had taken refuge in the vestibule of a house, and a girl of seventeen, Mlle. K., had sat down on the threshold, her back turned towards the street. Suddenly there was a violent clap of thunder, and in front of the door there appeared a dazzlingly brilliant ball of fire,

gradually descending towards where they were all grouped. After touching Mlle. K.'s head, who bowed down at once, the fireball fell on the ground in the middle of the party, made a circuit of it, then forcing its way into the room of the master of the house, whose boots it touched and singed, it wreaked havoc with the apartment, broke through the wall into a stove in the adjoining room, smashed the stove-pipe, and carried it off with such violence that it was dashed against the opposite wall, and went out through the broken window.

"After the first feeling of fright, this is what transpired. The door near which Mlle. K. was seated had been thrown back into the court, and in the ceiling there were two holes of about 18 centimetres each.

"The young girl, still seated with her head bowed down, looked as though she were asleep. Some of the people were walking in the courtyard, having seen and heard nothing, and the others were all lying in the vestibule in a dead faint. Mlle. K. was dead. The fireball had struck her on the nape of her neck and had proceeded down her back and left hip, leaving a black mark all along. There was a sore on one hand, with some blood on it, and one of her shoes was torn completely off, and there was a small hole in one of the stockings.

"All the victims became deaf."

On September 10, 1845, at about two in the afternoon, in the course of a violent storm, a fireball came down the chimney into a room in a house in the village of Salagnac (Creuse). A child and three women who were in the room suffered no harm from it. Then it rolled into the middle of the kitchen, and passed near the feet of a young peasant who was standing in it. After which it went into an adjoining room, and disappeared without leaving any trace. The women tried to persuade the man to go in and see whether he could not stamp it out, but he had once allowed himself to be electrified in Paris, and thought it prudent to refrain. In a little stable hard by, it was found afterwards that the fireball had killed a pig. It had gone through the straw without setting fire to it.

On July 12, 1872, a new form of fireball made its appearance in the Commune of Hécourt (Oise). It was of the size of an egg, and it was seen burning upon a bed. Efforts were made in vain to extinguish it, and presently the entire house, together with the neighbouring dwellings and barns, became a prey to the flames.

On October 9, 1885, at 8.25 p.m., during a violent storm, a globe of fire of the size of a small apple was seen coming into a ground-floor room in a house at

Constantinople through an open window, the family being at table in this room at the time. It first played round a gas-jet, then, moving towards the table, it passed between two guests, went round a lamp hanging over the centre of the table, and then precipitated itself into the street, where it exploded with an appalling crash, but without having caused any damage or hurt anybody. Not far from the scene of this phenomenon there are a number of buildings provided with lightning conductors. The fireball left no trace of smell behind it.

Here is another curious narrative of a fireball.

A party of five women took refuge during a storm in the entrance to a house in order to escape from the rain and the lightning.

They had scarcely gained the doorway when there was a tremendous thunderclap which sent them flying backwards—and two girls who had joined them—knocked senseless by lightning in the form of a fireball. One of the girls remained unconscious for a long time; all the others were more or less seriously injured, but all recovered. The strangest circumstance in connection with this affair, however, still remains to be told.

On the same side of the street as the passage, in a neighbouring house, nine or ten yards away, in a ground-floor room of which the door was shut, a young

SINGULAR CASE OF THREE FIREBALLS OBSERVED IN PARIS ON JUNE 10, 1905, BY M. H. RUDAUX.

They were seen to descend in this way upon the lightning conductor above the Palais Royal electric-power station. This engraving, after a sketch made at the time by M. Rudaux, appeared in *La Science Illustrée*, for Augnst, 1905.

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woman was working at a sewing-machine. At the moment of the thunderclap, she experienced a violent shock throughout her whole body, and a fierce burning sensation in the hollow of her back. It was found afterwards that between the shoulder-blades and also on her leg, she had been badly scorched, but the wounds quickly healed. Now, in the room of this victim, no trace was to be found of the passing of the fireball, neither on the ceiling, nor on the floor, nor on the walls. There was absolutely nothing to show how the electric fluid could have made its way in from the spot in which the fireball had exploded in the neighbouring house, separated from it by two thick walls.

Mysterious, is it not? The fireball seems to dwindle out of sight. In some cases, it seems to reduce itself into vapour in order to pass from one place to another.

With animals these fireballs seem deadlier and more merciless than with human beings.

Thus, on February 16, 1866, a thunderstorm descended upon a farm in the Commune of Chapelle-Largeau (Deux-Sèvres), and the circumstances attending its explosion are too remarkable to be overlooked. After a tremendous thunderclap, a young man who was standing near the farm saw an immense fireball touch the ground at his feet, but it did him no damage,

but passed, still harmlessly, through a room in the farmhouse in which there were nine persons. The only effect it produced was the flaring up of some matches upon the chimney-piece.

It proceeded towards the stables, which were divided into two compartments. In one there were two cows and two oxen: the first cow, to the right of the entrance, was killed, the second was uninjured; the first ox was killed, the second was uninjured.

The same effect was found to have been produced in the other compartment, in which there were four cows; the first and the third were killed, the second and fourth were spared: the odd numbers taken and the even numbers left.

Similar freaks have been recorded in connection with piles of plates struck by lightning—holes being found in alternate plates. How are these things to be explained?

The following story is very extraordinary, though it does not help to clear up the mystery of lightning's strange ways:—

On August 24, 1895, about ten in the morning, in the midst of a storm of wind and rain, several persons saw descending to the ground a whitish-coloured globe of about an inch and a half in diameter, which, on touching the ground, split into two smaller globes. These rose at once to the height of the chimneys on the

houses close by and disappeared. One went down a chimney, crossed a room in which were a man and a child, without harming them, and went through the floor, perforating a brick with a clean round hole of about the size of a franc. Under this room there was a sheep-fold. The shepherd's son, seated at the doorway, suddenly saw a bright light shining over the flock of sheep, while the lambs were jumping about in alarm. When he went up to them, he was startled to discover that five sheep had been killed. They bore no trace of burning, or of wound of any kind, but about their lips was a sort of foam, slightly pink in colour.

In the adjoining house, the second fireball had also gone down a chimney, and had exploded in the kitchen, causing great damage.

In 1890, a young farmer was working on a plot of ground, two or three miles from Montfort-l'Amaury. A storm breaking out, he stood up against his horses to take refuge from the rain; moving away a few yards in order to get his whip, there was seen, when he returned, a ball of fire almost touching the ear of one of his horses. A moment later it exploded with a deafening noise. The two horses fell—one of them unable to get up again. The farmer himself was dashed to pieces.

On other occasions the meteor is hardly more devastating than the ordinary bomb.

On April 21, at Lanxade, near Bergerac, a storm

had been raging already for some hours, when suddenly —simultaneously with a small thunderclap—a ball of fire, of the size of the opening of a sack of corn, fell slowly on one of the banks of the Dordogne, spoiling some fruit trees, and then crossing the river, it raised a waterspout several yards high as it went.

It disappeared finally on the other side of a field of corn.

On November 12, 1887, a very curious instance of a fireball was noticed on the Atlantic.

It was at midnight, near Cape Race. An enormous fireball was seen to rise slowly out of the sea to the height of sixteen or seventeen metres. It travelled against the wind, and came quite near the vessel from which it was being watched. Then it turned towards the south-east and disappeared. The apparition lasted about five minutes.

In July, 1902, in the course of a violent storm, and immediately after a loud peal of thunder, a fireball of about the size of a toy balloon was seen to make its appearance suddenly in the Rue Veron at Montmartre. After moving along, just above the ground, in front of a wine-merchant's shop, it exploded like a bomb, most fortunately without hurting any one, or doing any damage.

The little village of Candes, situated by the confluence of the Vienne and the Loire, was the scene of

the appearance of a fireball in June, 1897. Three persons were sitting in the verandah of a house during a storm, when they suddenly saw a fireball travelling past them through the air for a distance of thirty yards or so. Then it exploded with a loud noise, striking sparks from the ironworks of the verandah. At the same moment, the servants saw another fireball cross a garden at the other side of the house, and drop into a small pond. A gardener was knocked over, but not hurt.

On March 6, 1894, M. Dandois, professor of surgery at the University of Louvain, went to the neighbouring town of Linden, by railway, to see a patient. On his return, on foot, the sky suddenly so darkened over, that he made for the nearest dwelling-place, avoiding, as he did so, the telegraph poles along the road. Suddenly a ball of fire came against him and threw him over a ditch into a field, where he lay unconscious.

A quarter of an hour later, having regained his senses and finding himself undamaged save for a numbness in one arm and one leg, the doctor set out again, congratulating himself on the fact that his umbrella had acted as a sort of portable lightning conductor, for the steels were all twisted, and showed signs of having borne the brunt of the fray. Had the handle been of steel also, the electric current would

have run down it into his hand, doubtless, and killed him.

On another occasion a fireball fell upon the door of a house, pushed it violently open, and made its way into the kitchen.

At the sight of this strange visitor, the cook bolted from the room. A sempstress, who was at work near the window, received a small burn on her forehead, of about the size of half a franc, with a slight weal a couple of inches long—like the tail of a comet.

After bursting, the fireball made its way up the chimney, from which it removed a mass of soot, smelling somewhat of sulphur.

Here is an instance more curious still—

A violent storm was raging near Marseilles, when seven persons, seated together in the ground-floor drawing-room of a country house, saw a fireball as big as a plate appear in their midst.

It directed its course towards a young girl of eighteen, who, frightened out of her life, had fallen on her knees. Touching her shoes, it rebounded to the ceiling, then came down to her feet again, and so on two or three times, with mysterious regularity, the girl experiencing, it seems, no other sensation than that of a slight cramp in her legs. Eventually the fireball made its exit from the room through a keyhole!

The girl could not get up at once after it had gone. For a fortnight or so she could not walk without assistance, and it was two years before she got over a liability to sudden weakness in her legs, causing her suddenly to fall.

It is strange to reflect that these diminutive fireballs, produced by the actual atmosphere we breathe, are less understood by us than that enormous globe which we call the sun, and to which is due the flowering of the entire life of our planet. If we are still in doubt as to the nature of the sun's spots, at least we have been able to analyse its own elements. And we know its dimensions, its weight, its distance from us, its rate of rotation, etc., etc.

Yet these electric spheres that make their escape from the clouds in times of storm, baffle our investigations altogether.

According to records which seem authentic, fireballs have been seen actually to come into existence upon the surface of a ceiling, at the mouth of a well, and upon the flagstones of a church.

In 1713, at the chateau of Fosdinaro, in the neighbourhood of Massa Carrara, in the course of a storm and heavy downpour of rain, there was seen to appear suddenly upon the ground a very vivid flame, white and blue in colour. It seemed to flare fiercely, but did not move apparently from the one spot, and after growing

quickly in volume it suddenly disappeared. Simultaneously with its going, one of the observers felt a curious sort of tickling behind his shoulder, moving upwards; several bits of plaster from the ceiling under which he stood fell upon his head, and there was a sudden crash quite unlike an ordinary thunderclap.

In 1750, on the 2nd of July, at about three in the afternoon, the Abbé Richard happened to be in the church of St. Michel at Dijon during a storm. "Suddenly," he tells us, "I saw between two pillars of the nave a bright red flame floating in the air about three feet above the floor. Presently it rose to a height of twelve or fifteen feet, increasing in volume. Then, after having moved some yards to one side, while still rising diagonally to the height almost of the woodwork of the organ, it disappeared at last with an explosion like the report of a cannon."

On July 21, 1745, a violent storm broke out in Boulogne, and the tower of a convent was struck by a fireball. It was of great size, and was seen to emerge from one of the sewers of the town and to move along the surface of the road until it hit against this tower, of which a part subsided. No one was hurt. A nun affirmed that some years before she had seen just such another fireball emerge from the same spot and precipitate itself with a crash against the summit of the tower without doing any damage.

In the middle of a violent storm, Dr. Gardons saw several fireballs flying in different directions, not far from the ground, making a crackling sort of noise. One of them was seen by witnesses to come out of an excavation full of stagnant water. They killed one man, several animals, and did much damage to the trees and houses in the vicinity.

In February, 1767, at Presbourg, a blue, conical flame escaped suddenly with a detonating noise from a brasier, breaking it to pieces, and scattering the glowing cinders all around. It then went twisting about the room, burnt the face and hands of a child, escaped partly through the window, partly through the door, broke into a thousand pieces a second brasier in another room, and disappeared finally up a chimney, carrying up with it and discharging from the chimney-top into the street several hams which had been hung under the chimney-piece. For several days afterwards the atmosphere of the house retained a smell of sulphur.

In some cases, fireballs have been seen to come down from the sky apparently, and then, after almost reaching but not actually touching the ground, to ascend again. Thus on a hot day in summer 1837, M. Hapoule, a landed proprietor in the department of the Moselle, standing in front of the entrance to his stables under the shelter of a porch during a storm,

saw a fireball about the size of an orange moving in the direction of a dung-heap not far from him. But instead of going right into it, it stopped about a yard off, and changing its route, it went off at an angle, keeping the same level for some distance, when it suddenly seemed to change its mind again, and rose perpendicularly till it disappeared in the clouds.

These sudden changes, as we have seen, are strangely characteristic of the habits of fireballs.

The Garde Champêtre of the village of Lalande de Libourne (Gironde) was traversing the country one evening about half-past ten, engaged in organizing a *garde de surveillance*, when he suddenly found himself surrounded by a bright and penetrating light. Astonished, he looked behind him, and saw a fireball, just broken loose from a cloud, descending quickly to the ground.

The light vanished presently, but he made his way towards where the fireball seemed to be falling. When he had gone about two hundred yards, he saw another brilliant light breaking out from the top of a tree and spreading itself into a sheaf of rays, every point of which seemed to emit electric sparks.

At the end of a quarter of an hour the light became weaker, and then disappeared. The tree was afterwards cut down, and it was found that the lightning had gone down the centre to a distance of three yards, and had

then passed down outside to the soil, leaving trace of a semi-circular route; and finally, after rising again on the opposite side of the tree to a height of four yards, tearing off two narrow strips of bark, had disappeared. At the foot of the tree a small hole, about an inch and a quarter in diameter, retained a certain degree of warmth for an hour and a half afterwards.

Fireballs often keep within the frontiers of cloud-land. They may be seen passing sometimes from one cloud to another in the high regions of the atmosphere.

On September 22, 1813, at seven in the evening, M. Louis Ordinaire saw a fireball leave a cloud at the zenith—the sky being very much lowering at the time—and go towards another. It was of a reddish-yellow and extremely brilliant, lighting up the ground with a bright radiance.

He was able to follow its movements for at least a minute, and then saw it disappear into the second cloud. There was an explosion followed by a dull sound like the firing off of a cannon in the distance.

After a violent storm which broke out near Wake-field on March 1, 1774, there remained only two clouds in the sky, just above the horizon. Balls of fire were observed gliding from the higher of the two into the lower, like falling stars.

In high mountainous districts—in the Alps, for instance—you may often look down from above upon

a storm. It is fascinating thus to watch the grandiose spectacle of the elements at war. Here from the pen of Pere Lozeran du Fesch is a striking picture of such a scene—

"It was on the 2nd of September, 1716, about three o'clock in the afternoon. A traveller was making his way down towards Vic from the summit of Cantal, accompanied by a guide.

"The weather was calm and very warm, but down below, about the middle of the mountain, a vast sea of mist stretched out in wavelike clouds.

"These clouds were furrowed continually by lightning flashes, some going quite straight, some zigzag, some taking the shape of fireballs. When the two men came near this region of clouds, the mist grew so thick they could hardly see the bridles of their horses.

"The air became gradually more cold and the darkness more dense as they proceeded downwards. Now they were in the midst of the fireballs flying in every direction all round them, revolving as they went, reddish in colour, like saffron lit up.

"They were of all sizes—some quite small on their first appearance, seeming to grow immensely in volume in a few moments. Drops of rain fell when they passed. Up to this point the sight had been curious but not terrifying, but suddenly now, one of these fireballs, about two feet in diameter, burst open near

the traveller and emitted streams of a bright and beautiful light in every direction, and there was a dull report followed by a tremendous crash. The two men were much shaken and the air all round them seemed polluted. After a minute or two, however, all trace of the explosion had been dissipated, and they proceeded on their way."

On January 6, 1850, near Merlan, about six in the afternoon, a fireball burst above the heads of two men, enveloping them in a bluish light, without hurting them or even damaging their clothes, but giving them a momentary thrill as from an electric battery. It left no traces of any kind, not even a smell.

Mr. G. M. Ryan records an instance which he witnessed at Karachi in Scinde. While in his drawing-room one day with two friends who were taking refuge from a storm, he rose from his chair and went to the door to open it, the windows as well as the door being shut at the time. Returning, he saw in the air and between his friends, a ball of fire of about the size of a full moon. At the same time there was a terrible clap of thunder. Two of the spectators were slightly wounded; one felt a sharp pain on the left side of the face, the other, a sensation in one arm with a feeling as if his hair were burning. There was a strong smell of sulphur. In the next room there were two rifles in a

case; one was intact but the other was broken, and there was a hole in the wall at the point where the muzzle leant against it, and there were two holes in the same wall a story higher.

On Sunday, August 19, 1900, several people were assembled in a room in the château of the Baron de France at Maintenay (Pas-de-Calais), when there was a violent storm raging over the country.

Suddenly there appeared in the midst of the eleven people who were there, a globe of blue fire about the size of an infant's head, which quietly crossed the room, touching four people on its way. None of them were injured. An awful explosion was heard at the moment when the electric ball disappeared through an open door in front of the great staircase.

On August 3, 1809, a fireball struck the house of a Mr. David Sutton, not far from Newcastle-on-Tyne. Eight people were having tea in the drawing-room when a violent clap of thunder knocked down the chimney.

Immediately after they saw on the ground, at the door opposite the fireplace, the brilliant visitor which announced itself in the sonorous voice of Jupiter the thunderer. It remained discreetly at the entrance of the room, no doubt waiting for the sign to advance. No one making a move, it came into the middle of the

room, and there burst with a crash, throwing out fiery grains like aeroliths.

The spectacle must have been magnificent—but, we must acknowledge, rather disquieting.

On September 27, 1772, at Besançon, a voluminous fireball crossed over a corn-shop and the ward of a hospital full of nurses and children. This time again the lightning was merciful—it spared nurses and children, and went and drowned itself in the Doubs.

Nearly thirty years before, in July, 1744, it showed the same regard for an honest German peasant woman. She was occupied in the kitchen superintending the family meal, when, after a terrible clap of thunder, she saw a fireball the size of a fist come down the chimney, pass between her feet without hurting her, and continue on its course without burning or even upsetting the spinning-wheel and other objects on the floor.

Much frightened, the young woman tried to escape; she threw herself towards the door and opened it, when the fireball at once followed her, played about her feet, went into the next room, which opened out-of-doors, crossed it, and through the door into the yard.

It went round the yard, entered a barn by an open door, climbed the wall opposite, and reaching the edge of the roof, burst with such a terrific noise that the

peasant woman fainted. The barn at once took fire and was reduced to cinders.

Towards the middle of the last century, March 3, 1835, the steeple of Crailsheim was set on fire by lightning. The guardian's daughter, aged twenty years, was at this moment in her room and had her back turned to the window, when her young brother saw a fireball enter by the window-sill and descend on to his sister's back, giving her a sudden shock all over her body. The young girl then saw at her feet a quantity of small flames, which went towards the kitchen, the door of which had been opened, and set fire to a pile of mossy wood. There was no further damage than this attempt at incendiarism, which was easily extinguished.

Occasionally a fireball seems to take a malignant pleasure in hurling itself like a fury against lightning conductors; but instead of quietly impaling itself like the linear lightning, and breathing its last sigh in a prolonged roar, it struggles, and comes forth victorious from this curious contest.

There are many cases of fireballs playing about the lightning conductors without being caught.

In 1777, a fireball shot from the clouds on to the point of the lightning conductor on the Observatory of Padua. The conductor, which consisted of an iron chain, was broken at its junction with the stem. However, it sent on the discharge.

Some years later, in 1792, a huge ball of lightning struck one of the two conductors on the house of M. Haller at Villiers la Garenne. This conductor was much injured by the audacious assailant, and so was the framework of the house; the keen fluid had damaged the metallic gutters.

At this point I must add that lightning conductors are of recent creation. Nor would it be surprising if there were defective ones which could not assure an efficient protection.

However, much later, on December 20, 1845, the same phenomenon was observed at the château of Bortyvon, near Vire. There, again, the fireball, ignoring the danger to which it was exposing itself, flung itself on a lightning conductor placed in the centre of the château. It was spared, but the château suffered greatly. The electric ball descended from both sides of the metallic stem, causing a great deal of damage along its path. On touching the ground it expanded, and many persons affirm that they saw what was like a huge cask of fire rolling along the ground.

In truth, ball lightning seems in a certain measure to escape the influence of lightning conductors.

On September 4, 1903, towards ten o'clock in the evening, M. Laurence Rotch, director of the Observatory of Blue Hill (U.S.), happening to be in

Paris, made the following curious observation from the Rond-point of the Champs Elysées.

Looking in the direction of the Eiffel Tower, he saw the summit of the edifice struck by white lightning coming from the zenith. At the same moment a fire-ball, less dazzling than the lightning, slowly descended from the summit to the second platform. It appeared to be about one yard in diameter, and to be situated in the middle of the tower, taking less than two seconds to cover a distance of about 100 yards. Then it disappeared. The next day the observer ascertained, on visiting the tower, that it had actually been struck by lightning twice on the previous day.

It is to be noted that the meteor did not follow the conductor; but, after all, is not the whole tower itself the most powerful conductor imaginable? Would not the enormous masses of iron used in its construction neutralize the attraction of the thin metallic rods, effectual for the protection of ordinary buildings, but incapable, one would think, of competing with the attractive force of this immense metallic framework?

Here are some cases where globular lightning has struck bells or telegraph wires, which it has followed with docility.

Several times it has been seen poised like a bird on a telegraph wire near a railway-station, and has then quietly disappeared.

THE EIFFEL TOWER AS A COLOSSAL LIGHTNING CONDUCTOR.

Photograph taken June 3, 1902, at 9.20 p.m., by M. G. Loppé. Published in the *Bulletin de la Société Astronomique de France* (May, 1905). [*Page* 82.

We see that it is not absolutely inimical to points, nor to metals, but it prefers its independence, and he must get up early who would catch it in a snare.

It is an anarchist—it acknowledges no rule.

But we must confess that if spheroidal lightning seems particularly capricious, it is because we are still ignorant of the laws which guide it. Our ignorance alone is the cause of the mystery.

We try to discover the enigma in the silence of the laboratories, where physicians question science without ceasing; we try to reproduce fireballs artificially, but the problem is complicated, and its solution presents enormous difficulties.

Hypotheses are not wanting. Some years ago, M. Stéphane Leduc recorded an interesting experiment, producing a moving globular spark.

When two very fine and highly polished metallic points, each in affinity with one of the poles of an electro-static machine, rest perpendicularly on the sensitive face of a gelatine bromide of silver photographic plate, which is placed on a metallic leaf, the two points being 5 to 10 centimetres the one from the other, an effluvium is produced round the positive point, while at the negative point a luminous globule is formed.

When this globule has reached a sufficient size, you can see it detach itself from the point, which

ceases to be luminous, begin to move forward slowly on the plate, make a few curves, and then set off for the positive point; when it reaches this, the effluvium is extinguished, all luminous phenomenon ceases, and the machine acts as if its two poles were united by a conductor.

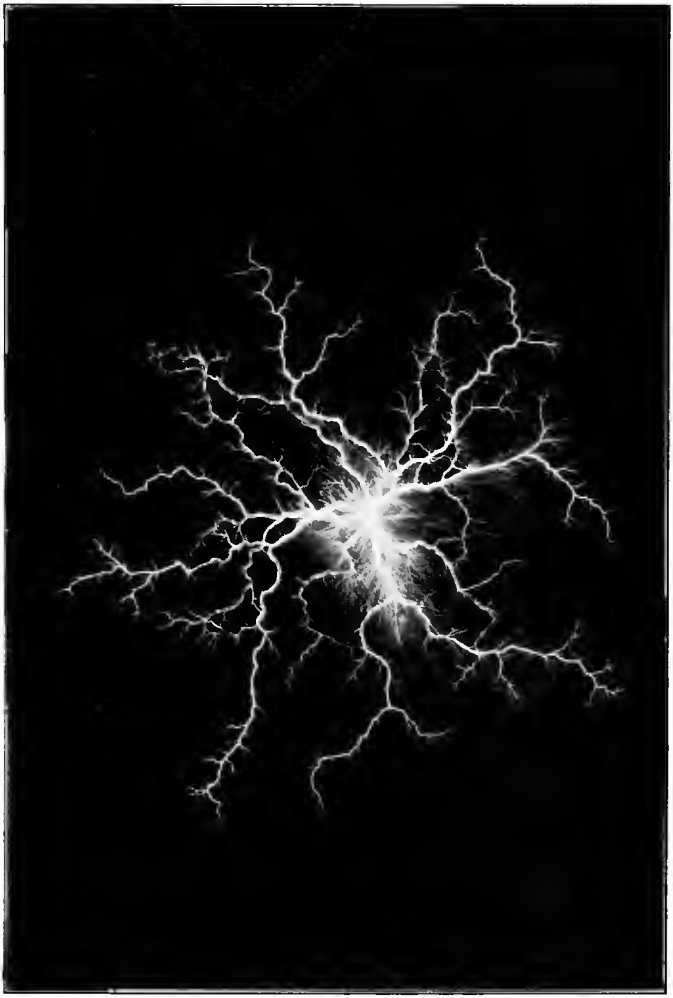
The speed with which the luminous globe moves is very slight. It takes from one to four minutes to cover a distance of 5 to 6 centimetres. Sometimes, before reaching the positive point, the globe bursts into two or more luminous globules, which individually continue their journey towards the positive point.

On developing the plate, you will find traced on it the route followed by the globule, the point of explosion, the routes resulting from the division, the effluvium round the positive point. Also, if you stop the experiment before the arrival of the globule at the positive point, the photograph will only give the route to that point.

The globule makes its course the conductor. If during its journey you were to throw powder on the plate—sulphur, for example—the course it followed will be marked by a line of little aigrettes, looking like a luminous rosary.

Of all the known electric phenomena, this is the most analogous with globular lightning.

But the really complicated part of the question



PHOTOGRAPH OF THE POSITIVE POLE OF AN ELECTRIC SPARK.

[*Page* 84.

PHOTOGRAPH OF THE NEGATIVE POLE OF AN ELECTRIC SPARK.

[*Page* 84.

is when ball lightning loses part of its fluidity and becomes a semi-solid body, as in the following instance :—

On April 24, 1887, a storm burst over Mortrée (Orne), and the lightning literally chopped the telegraph wire on the route to Argentan for a distance of 150 yards. The pieces were so calcinated that they might have been under the fire of a forge; some of the longer ones were bent and their sections welded together. The lightning entered by the door of a stable in the form of a fireball, and came near a person who was preparing to milk a cow; then it *passed between the legs of the animal*, and disappeared without causing any damage. The terrified cow raised itself on its hind legs with frantic bellowing, and its master ran away, frightened out of his wits, but there was no harm done.

The inexplicable phenomenon was that at the precise moment when the lightning crossed the stable, a great quantity of incandescent stones fell before a neighbouring house. "Some of these fragments, of the size of nuts," wrote the Minister of Post and Telegraphs at the Academy, "are of a not very thick material, of a greyish-white, and easily broken by the fingers, giving forth a characteristic odour of sulphur. The others, which are smaller, are exactly like coke.

"It would perhaps be useful to say here, that during this storm the thunderclaps were not preceded by the ordinary muttering, they burst quickly like the discharge of musketry, and succeeded one another at short intervals. Hail fell in abundance, and the temperature was very low."

It is only by a semblance of disbelief that one can get the peasants to tell us the stories of what they pretend to have seen of the fall of aeroliths during storms. They have christened the uranoliths "thunderstones."

These substances have evidently no relation to uranoliths, but they prove none the less that ponderable matter may accompany the fall of lightning.

Here are two more examples—

In the month of August, 1885, a storm burst over Sotteville (Seine-Inférieure); lightning furrowed the sky, the thunder muttered, and the rain fell in torrents. Suddenly, in the Rue Pierre Corneille, several small balls, about the size of a common pea, were seen to fall; these burned on touching the ground, sending out a little violet flame. People counted more than twenty, and one of the spectators, on putting her foot on one of them, produced a fresh flame. They left no trace on the ground.

On August 25, 1880, in Paris, during a rather

violent storm, in broad daylight, M. A. Trécul, of the Institute, saw a very brilliant voluminous body, yellowish-white, and rather long in shape, being apparently 35 to 40 centimetres in length, by about 25 in width, with slightly conical ends.

This body was only visible for a few seconds; it seemed to disappear and re-enter a cloud, but in departing—and this is the chief point—it dropped a little substance, which fell vertically like a heavy body under the sole influence of gravity. It left a trail of light behind it, at the edges of which could be seen sparks, or rather red globules, because their light did not flash. Near the falling substance the luminous trail was almost vertical, while in the further part it was sinuous. The small substance divided in falling, and the light went out soon after, when it was on the point of reaching the tops of the houses. When it was disappearing, and at the moment of the division, no noise was heard, although the cloud was not far away.

This fact incontestably proves the presence of ponderable matter in clouds, which is not violently projected by an explosion in the bolis, nor accompanied by a noisy electric discharge.

We are still far from understanding the interesting problem of the formation and nature of ball lightning. Instead of denying it, men of science ought to study

it, because it is certainly one of the most remarkable of the curiosities of atmospheric electricity.

We must begin by finding out the exact facts, which are extraordinary enough to captivate our attention. The theories will follow.

CHAPTER V

THE EFFECTS OF LIGHTNING ON MANKIND

THE destructive work of lightning in every form is immense. A formidable and invisible world skirts the earth—an enchanted world, more wonderful than any Eastern legend—an unknown ocean, whose immaterial presence is constantly brought before us by the most fearful electric conflagrations.

Even to-day the brilliancy of lightning hides itself from us in the darkness of impenetrable mystery. But we feel that there is an immeasurable power, an unimaginable force which rules us.

We are, in fact, but puny beings in comparison with this magic force, and the ancients were wise when they made the King of the Gods responsible for the actions of lightning. He alone in His splendour and sovereignty could exercise such an empire over our modest planet—above all, over man's imagination.

Science slowly follows the centuries in their ascending march towards progress. At present our knowledge of ball lightning is limited, and we have only the

principal facts of nature to contribute to the elucidation of the problem.

In increasing our observations, and in comparing those which are analogous, we may hope, if not to arrive at an immediate conclusion, at least to help in the work of discovering what laws govern this subtle and imponderable fluid.

Here it will strike a man dead without leaving a trace; there it will only attack the clothes and insinuate itself as far as the skin without even grazing it. It will burn the lining of a garment, and leave the material of which it is made intact. Sometimes it profits by the bewilderment caused by its dazzling light to entirely undress a person, and leave him naked and inanimate, but with no external wound, not even a scratch.

We find as many peculiarities as facts.

Some of the actions of lightning remind one of the fantastic stories of Hoffmann and Edgar Poe, but nature is more wonderful than the imagination of man, and lightning remains supreme in its phantasmagoria.

Thunder seems to play with the ignorance of man; its crimes and jests would have been ascribed to the devil in olden days. We submit to the effects without being able to determine the cause which directs them.

It would seem as if lightning were a subtle being—a medium between the unconscious force which lives in

plants and the conscious force in animals. It is like an elemental spirit, keen, capricious, malicious or stupid, far-seeing or blind, wilful or indifferent, passing from one extreme to another, and of a unique and terrifying character. We see it twisting into space, moving with astonishing dexterity among men, appearing and disappearing with the rapidity . . . of lightning . . . it is impossible to define its nature.

At all events, it is a great mistake to trifle with it. It means running great risks. It resents being interfered with, and those who try to probe into its domain are generally rather cruelly put in their place.

It was an indiscretion of this kind which cost Dr. Richmann his life.

He had fixed an insulated iron rod from the roof of his house to his laboratory; this conducted the atmospheric electricity to him, and he measured its intensity every day. On August 6, 1753, in the middle of a violent storm, he was keeping at a distance from the rod in order to avoid the powerful sparks, and was waiting for the time to measure it, when, his engraver entering suddenly, he took a few steps towards him which brought him too near the conductor. A globe of blue fire, the size of a fist, struck him on the head and stretched him stone dead.

This beginning to the study of physics was hardly encouraging.

The visitations of lightning are so numerous that it would naturally be impossible to describe them all in this small collection. We must, therefore, choose among them, but here we encounter a great difficulty. Among the thousands of *tours de force* and of dexterity accomplished by lightning, which should we take and which leave? The selection is very difficult, as it means leaving out a large number of curious examples with a good many very interesting observations.

We will choose the most important—those of which the authenticity appears incontestable, and which contain the most precise details. We will group together those among them which present points of resemblance. This approximate classification will give us a sufficiently complete picture for the harmony of this study.

* * * * *

One of the most astonishing actions of lightning is certainly that of leaving the victim in the very attitude in which he was surprised by death.

Cardan gives an extraordinary example of this kind.

In the course of a violent storm, eight reapers, who were taking their meal under an oak, were struck, all eight of them, by the same flash of lightning, the noise of which could be heard a long way off. When the passers-by approached to see what had happened, the reapers thus suddenly petrified by death, appeared

to be continuing their peaceful meal. One held his glass, another was carrying the bread to his mouth, a third had his hand on the dish. Death had seized them all in the position which they occupied when the explosion occurred.

We hear of many similar cases to this.

Here is one of a young woman who no doubt was struck by lightning in the position in which she was found after the accident. It was during a violent storm on July 16, 1866; she was alone in the house at Saint-Romain-les-Atheux (Loire), and outside the thunder rolled fearfully. When her parents came back from the fields, they found a sad sight. The young woman had been killed by lightning. They found her kneeling in a corner of the room with her head buried in her hands; she had no trace of a wound. Her child of four months, who was in bed in the same room, was only lightly touched.

Quite recently, on May 24, 1904, at Charolles (Saône-et-Loire), a certain Mlle. Moreau, who lived at Lesmes, was waiting for the end of a storm in a grocer's shop where she had been making some purchases. Several people were gathered round the fireplace. They felt a great movement following a violent clap of thunder. The sensation having passed, every one prepared to go. Mlle. Moreau alone remained seated, and did not move. She had been struck by the fluid, which

had made a hole under her right ear and come out by the left!

The petrifying action of the electric fluid is so rapid that horsemen who have been struck have remained on horseback and been carried a long way from the place of the accident without being unsaddled.

According to Abbé Richard, towards the end of the eighteenth century, the procurator of the Seminary of Troyes was coming home on horseback when he was struck by lightning. A brother who followed him, not perceiving this, thought that he was asleep when he saw him reeling. When he tried to awaken him, he found he was dead.

The following observation is very remarkable on account of the special attitudes preserved by the bodies which had been struck:—

A vessel which was at Port Mahon was struck at the time when the crew were dispersed over the yards to furl the sails. Fifteen sailors who were scattered on the bowsprit were killed or burned in the twinkling of an eye. Some were thrown into the water; others, bent dead across the yard-arm, remained in the position they had occupied before the accident.

Often the corpses of people who have been struck have been found either sitting or standing.

At the approach of a storm a vine-dresser was seated under a nut tree which was planted near a

hedge: soon afterwards, when it had ceased raining and the thunder was quiet, his two sisters, who had been taking shelter under the hedge, saw him sitting, and called to him to go back to work, but he did not reply; on going up to him, they found him dead.

In 1853, in the neighbourhood of Asti, a priest who was struck while dining remained in his place.

In 1698, a ship was struck at about four o'clock in the morning, not far from Saint-Pierre. At daybreak a sailor was found sitting stone dead at the bow of the ship, with his eyes open and the whole body in such a natural attitude that he seemed to be alive. He had suffered no injury either external or internal.

Dr. Boudin describes a still more surprising case. A woman was struck while she was in the act of plucking a poppy. The body was found standing, only slightly bent and with the flower still in her hand. It is hard to understand how a human body could remain standing, slightly bent, without a support to prevent its falling. This case is a contradiction to all the laws of equilibrium. But with such a fantastic agent as that with which we are dealing, nothing is surprising—we may expect anything. Thus—

On August 2, 1862, lightning struck the entrance pavilion of the Prince Eugene barracks in Paris just when the soldiers were going to bed. All those who

were lying down suddenly found themselves standing, and those who were standing were thrown on the ground.

In the preceding examples the victims struck dead are not disfigured by the fulgurant force. They preserve a deceptive appearance of life. The catastrophe is so sudden that the face has no time to assume a sad expression. No contraction of the muscles reveals a transition in the passage of life and death. The eyes and mouth are open as though in a state of watching. When the colour of the flesh is preserved, the illusion is complete. But when we approach these statues of flesh—so lately animated with vital fire, now mummified by celestial fire—we are surprised on touching them to find that they crumble to ashes.

The garments are intact, the body presents no difference, it keeps the attitude it had at the supreme moment, but it is entirely burnt, consumed. Thus—

At Vic-sur-Aisne (Aisne) in 1838, in the middle of a violent storm, three soldiers took shelter under a lime tree. Lightning struck them all dead at one blow. All the same, they all three remained standing in their original positions as though they had not been touched by the electric fluid: their clothes were intact! After the storm some passers-by noticed them, spoke to them without receiving an answer, and went up to touch them, when they fell pulverized into a heap of ashes.

This experience is not unique, and even the ancients

remarked that people who were struck crumbled to dust.

Here is a similar case, no less curious—

On June 13, 1893, at Rodez, a shepherd named Desmazes, seeing that a storm was threatening, collected his beasts and drove them quickly towards the farm. When he was just there, he was struck by lightning. His body, which was completely incinerated, preserved a natural appearance.

It is by this complete incineration and the probable volatilization of the cinders that certain authors explain the sudden disappearance of some of those who have been struck.

Legend attributes the mysterious death of Romulus to a similar cause. According to Livy, the illustrious founder of Rome was reviewing his army in a plain near the marsh of Capra. Suddenly a storm accompanied by violent claps of thunder enveloped the king in a cloud so thick that it hid him from sight. From that moment Romulus was seen no more on earth.

It is true, Livy adds, that some of the witnesses suspected the senators of having torn him to pieces: kings have sometimes been subject to all kinds of surprises on the part of their "courtiers."

In most cases the electric matter produces burns more or less severe. These, when they do not attack

the whole organism as in the preceding examples, are localized to certain parts of the body. Sometimes they are quite superficial and only attack the epidermis. Often without absolute carbonization, they penetrate deep into the flesh and cause death after the most fearful suffering.

Here are some examples of different sorts of burns—

In 1865, in the Rue Pigalle in Paris, a man had his eyes burnt by lightning.

A young soldier of the 27th Battalion of Chasseurs was armed, mounting guard at the Col de Soda. It was in the month of July, 1900. Suddenly he was surrounded by the dazzling glare of lightning, which was almost immediately succeeded by an awful explosion of thunder. The sentinel, leaving his arms, fell backwards screaming. People ran to him, and saw that the fluid, attracted by the point of the bayonet, had struck it, and, gliding down, the metal had burnt his feet rather severely.

At Malines, in Belgium, a mill was reduced to splinters by the fire of heaven. The miller and two of his customers were there at the time of the accident. Not one of the three men was killed, but the miller was seriously burnt in the head, on the chin and the cheeks. He was deaf and blind for twenty-four hours. One of the others was burned in the hands.

On June 19, 1903, at about six in the evening,

during a bad storm, five farmers were crossing the Champ de Gentillerie near Saint-Servan, in order to take shelter. Three of them were walking abreast, the two others, of whom one was leading an ass, were some paces behind, when suddenly the five men and the ass were thrown on the ground by a violent clap of thunder. Three of the farmers, recovering their consciousness after the shock, observed that their two companions were struck; the head of one was carbonized, and the left side of the other was burnt as though by a red-hot iron.

Another phenomenon, no less appalling—

A woman who was struck had her leg so horribly burnt that, on removing the stocking, some particles of flesh adhered to it. From the knee to the end of the foot the skin was black as though carbonized, and the whole surface was covered with a species of blister full of a sero-purulent liquid. The burns were very serious but not mortal, and were localized in the leg.

Lightning also sometimes produces wounds which are more or less severe. It perforates the bones. The injuries it causes are similar to those inflicted by fire-arms.

It can also cause partial or total paralysis, the loss of speech or sight, temporary or permanent. Its action is manifold on the human organism.

A more extraordinary phenomenon still is that

people who are struck show no sign of the slightest injury on a minute medical examination. The ancients remarked this, as we see in the charming passage from Plutarch: "Lightning struck them dead without leaving any mark on the bodies nor any wound or burn—their souls fled from their bodies in fright, like a bird which escapes from its cage."

We have already spoken of the smell of fulminated air and of ozone. In some cases there is more than that.

On June 29, 1895, lightning struck a low house at Moulins in the course of a violent storm. The fluid, eccentric as usual, attacked the outer chimney, the bricks of which were loose and projected slightly. It broke some tiles on the roof, the length of one rafter, and inside the corn-loft it broke the wooden handle of an iron rake to splinters. On the ground floor, bricks were both loosened and torn out near where the pipe of the stove went into the wall of the chimney-piece.

A dozen plates were broken in a cupboard to the left of the hearth, and a woman who happened to be near it at the time of the explosion, said she had felt her legs warmed by the burning air which came from the cupboard. The room was afterwards filled with a thick infected smoke, a veritable poison.

Sometimes the victims are nearly asphyxiated by

the fulminic effluvium, and only owe their preservation to the extreme care which is lavished on them.

Very often the bodies and the clothes of people who have been struck give forth a nauseous smell—generally similar to that of burning sulphur.

In the month of August, 1879, a woman who had been struck at Montoulieu, in the Champ Descubert quarter, had her skull perforated as though a big ball had passed through it, and her burnt clothes gave forth insupportable emanations.

Dr. Minonzio relates how three persons were wounded by lightning on board the Austrian frigate *The Medée*. "I remember," he says, "the sensation which was caused in the locality by the stench which came from the bodies and clothes of these people who were struck—a stench nearly as offensive as that of burnt sulphur mingled with empyreumatical oil."

One of the most frequent and good-natured effects of lightning on man is to shave his hair and beard, to scorch them, or even to depilate the whole body.

Generally the victim may consider himself lucky if he leaves a handful of hair as a ransom to the lightning, and escapes with a fright.

There is even a case given of a young girl of twenty who had her hair cut as though by a razor, without perceiving it or feeling the least shock.

On May 7, 1885, two men who were in a windmill were struck by lightning. They were both struck deaf, and the hair and beard and eyebrows of one were burnt. In addition to this, their clothes crumbled to the touch.

A man, who must have been very hairy, was struck by lightning near Aix. The electric current raised the hairs of his body in ridges from the breast to the feet, rolled them into pellets, and incrusted them deeply in the calf of the leg.

Very often the injury to the hair, instead of being spread all over the body, limits itself to certain places where it is thicker or damper on the body of a man, and more especially on that of a woman. Here are some curious examples.

In Dr. Sestier's learned work, vol. ii. p. 45, we read the following case observed at Montpellier :—

"Accidit apud Monspelienses ut fulmen cadens in domum vicarii generalis de Grassi pudendum puellae ancillae pilos abraserit ut Bartassius in muliere sibi familiari olim factum fuisse."

Toaldo Richard has described similar experiences, and d'Hombres Firmas has described several others :—

A number of people were assembled at Mas-Lacoste, near Nîmes, when lightning penetrated to where they were. A girl of twenty-six was thrown over and became unconscious ; when she came to her senses, she could

hardly support herself or walk, and felt a great deal of pain in the centre of her body. When she was alone with her friends, they examined her, and they saw "non sine miratione pudendum perustum ruberrimum, labia tumefacta pilos deficientes usque ad bulbum punctosque nigros pro pilis, inde cutim rugosissimam; ejus referunt amicae primum barbatissimam et hoc facto semper imberbem esse."

Lightning is indeed a joker, but so it has always been.

In most cases the hair grows again, but sometimes the system is completely destroyed, and the victim must either wear a wig or go bald.

We have already spoken further back of the case of Dr. Gaultier, of Claubry, who was struck one day by globular lightning, near Blois, and had his beard shaved off and destroyed for ever; it never grew again. He nearly died of a curious malady, his head swelled to the size of a metre and a half in circumference.

We also hear of corpses of people who have been struck, which show no other injury than a complete or partial epilation.

For example, a woman who was struck in the road had the hair completely pulled out of the top of her head.

On July 25, 1900, a farm servant, Pierre Roux, was killed while in the act of loading a waggon of hay.

The only trace the lightning left behind it was to completely scorch the beard of its victim.

Now, here is a case the complete opposite of the preceding ones and still more curious, in which the capricious and fantastic lightning attacked the epidermis without burning the hair which covered it.

At Dampierre thunder broke over a house belonging to M. Saumois. His arm, one leg, and the left side of his body were burnt, and the extraordinary thing is that the skin of the arm was burnt leaving the hair intact.

A little further on we shall have cases where the lightning has proved salutary in certain forms of illness.

Generally the people who are struck fall at once without a struggle.

It has been proved by a great number of observations that the man who has been struck by lightning so as to lose consciousness immediately falls without having seen, heard, or felt anything. This is easy to believe, since electricity is animated by a movement much quicker than that of light, and still more so than that of sound. The eye and ear are paralyzed before the lightning and the thunder could have made an impression on them; so much so that the victims, when they recover themselves, are unable to explain what has happened to them.

People struck by lightning nearly always sink on the very spot where they have been struck. Besides this, we have already remarked several cases where the people struck have preserved the exact positions they had at the moment of the catastrophe.

But, on the other hand, we can quote some examples, rarer, but diametrically opposed to these.

On July 8, 1839, lightning struck an oak near Triel (Seine-et-Oise), and also struck two quarrymen, father and son. This last was killed dead, raised, and transported twenty-three yards away.

The surgeon Brillouet was surprised by a storm near Chantilly, and was raised by the lightning and deposited twenty-five paces from where he had been.

On August 18, 1884, at Namur (Belgium), a man was flung ten yards from the tree under which he had been struck by lightning,

The following notice was in the papers in August, 1900 :—

" Brousses-et-Villaret (Aude), August 20. During the storm which burst over that region the lightning killed two cows belonging to M. Bouchère. It also struck, but without hurting him, a young man of twenty-three years of age, Bernard Robart, artilleryman, who was taking a holiday. He was walking to a neighbouring farm when he was suddenly carried through the air for fifty yards. He got up again without any hurt, onlv

he was dazzled by the lightning which had flashed before his eyes."

On writing to the victim to verify this fact, I received the following answer :—

"I have the honour to inform you that the article relating to the incident which happened to me during the lightning, on the 17th, is absolutely true.

"I was on leave at Brousses, Canton of Saissac (Aude). I left my uncle's house at about 8 p.m. There had been a heavy storm. The rain had nearly stopped for about two or three minutes, but it still fell a little. There had been a good deal of thunder during the storm. I was sleeping at home, the house being about two hundred yards away. It was very dark, and seeing that the rain was going to begin again with violence, I started to run. I went very quick. I was crossing the Place, and when I arrived in front of M. Combes' house, I suddenly felt myself stopped, and without being able to explain how, I found myself in the same instant at the other side of the Place, lying on the ground against the wall of M. Maistre's house. I was astounded; I waited a good minute without knowing where I was. When I got home I felt a severe pain in the right knee, and I perceived that my trousers were torn and that I had a big scar on my knee, and that my hands were slightly scorched. It

must have happened against the wall where there were some loose stones. I was transported about fifty yards, and I cannot tell you if it thundered at the same time, but there had been a big clap about a minute before. Two people who were leaving M. Combes' house were witness of the fact. The lightning penetrated into M. Bouchère's stables two hundred yards away, and killed two cows and broke the leg of another. As it went in it broke the cover of the doorway, which was of freestone, in two, and knocked over a chair and seven or eight bottles which were on a shelf.

"Believe me, etc.,

"BERNARD ROBERT,

"Artilleryman, Fort Saint Nicholas,

"Marseilles."

Thus we have several examples of people being transported 20, 30, and 50 yards from the point where the lightning has struck them.

Sometimes the bodies of people who are struck are as stiff as iron and retain their stiffness.

On June 30, 1854, a waggoner, thirty-five years of age, was struck in Paris. The next day Dr. Sestier saw his corpse at the Morgue: it was perfectly stiff. The next day, forty-four hours after the death, this stiffness was still most marked.

Some years ago, in the Commune of Hectomare

(Eure), lightning struck a man named Delabarre, who was holding a piece of bread in his hand. The contractility of the nerves was so strong that it could not be taken from him.

On the other hand, the bodies very often remain flexible after death, as in life.

On September 17, 1780, a violent storm burst over Eastbourne. A coachman and footman were killed. "Although the bodies remained from Sunday to Tuesday unburied," remarked an observer, "all their limbs were as flexible as those of living people."

Sometimes the corpses soften and decompose rapidly, leaving an unbearable odour.

On June 15, 1794, lightning killed a lady in a ballroom at Fribourg. The corpse rapidly gave forth a curious odour of putrefaction. The doctor could hardly examine it without fainting. The inhabitants of the house were obliged to go away thirty-six hours after the death, the odour was so penetrating. It was with difficulty that they were able to put the fetid corpse into a coffin. It fell to pieces.

The flabbiness often observed in the bodies of people who are struck is due, no doubt, to the fact that in the case of enormous discharge, the stiffness of a dead body develops so quickly, and is of such a short duration, that it may escape observation.

Numbers of experiments made on animals justify this hypothesis.

Nevertheless, in the majority of cases, bodies which have been struck decompose rapidly, which explains quite naturally the softness of bodies killed by lightning.

The colouration of these presents numerous varieties; sometimes the face is of a corpse-like paleness, at others it preserves its natural colour.

In many cases, the face is livid, red, violet, violet-bronze, black, yellow, and even covered over with brown or blue spots.

The colouration of the face may be extended over all or nearly all the body.

The eight reapers who were killed under an oak, quoted by Cardan in our first example, were quite black.

That the subtle fluid accumulated in great masses in the clouds should kill a man, deprive him of movement, annihilate his faculties, or slightly wound him—this ought not to astonish us when we contemplate the marvellous results and the prodigies of strength accomplished by the much more feeble electricity of our laboratories.

But the extraordinary point about lightning is its variety of action. Why does it not invariably kill those it strikes? and why does it sometimes not even wound them?

There are inexplicable subtleties in the world.

One knows of many examples of people who are struck whose garments remain absolutely intact. The imponderable fluid insinuates itself through the garments, leaving no trace of its passage, and may cause grave disorders in the body of a man without any exterior mark to reveal it to the most perspicacious observer.

We hear of the case of a man who had nearly the whole of his right side burnt from the arm to the foot, as though it had been for a long time too near a quick fire, but his shirt, his pants, and the rest of his clothes were untouched by the fire.

The Abbé Pinel gives the case of a man who, amongst other injuries, had his right foot very badly lacerated, while the left was untouched; the right sabot was untouched, and the left was broken.

On June 10, 1895, at Bellenghise, near Saint-Quentin, a lady was killed under a tree: she had deep marks of burning on the breast and stomach, but her clothes remained intact. Lightning is very mystifying.

Th. Neale cites a case where the hands were burnt to the bone in gloves which remained intact!

At other times, garments, even those nearest the skin, are perforated, burnt, and torn, without the surface of the skin being injured.

Thus the boot of a man who had been struck was

so torn that it was reduced to ashes, while there was no trace of a wound on the foot.

An extraordinary case in point happened at Vabreas (Vaucluse) in July, 1873. A peasant was in the fields when there was a violent clap of thunder. The electric fluid struck his head, shaved the left side, and completely burnt his hat. Then, continuing its route, it tore his garments, penetrated the length of his legs, and tore his trousers from top to bottom. Finally, it transported the unfortunate man, nearly naked, six or seven yards from his original place, and laid him on his stomach on a bush with his head hanging over the edge of a river.

Sometimes, when the garments are seriously injured, we find slight injuries under the skin which do not always correspond to the places where the garment is most seriously affected.

Lichtenberg quotes the case of a man who had his clothes cut as by the point of a knife from the shoulders to the feet, without the sign of a wound except a small sore on the foot under the buckle of the shoe.

According to Howard, a man had his clothes torn to atoms without showing any trace of the action of the electric fluid on the surface of his body, except a light mark on the forehead.

Sometimes, as we have already said, the inner garments are burnt while the outer ones are respected.

A woman had her chemise scorched by the fire of heaven, while her dress and petticoats were spared.

On June 14, 1774, lightning fell at Poitiers in a yard where a young cooper was working. It went under his right foot, burning his shoe, passed between his stocking and leg, singed the stocking without wounding the leg, burned the lining of his trousers, raised the epidermis of the abdomen, tore off a brass button which fastened his garment, and went off to twist a carpenter round in a neighbouring lane. Neither one nor the other felt the effects of this stroke of lightning.

Finally, the clothes, above all the shoes, are unsewn carefully and without a tear, as though by the hand of a clever workman.

Here are two cases in a thousand—

On June 18, 1872, at Grange Forestière, near Petit-Creusot, a man had his trousers unsewn from top to bottom and his shoes taken off.

In the department of Eure-et-Loire, some peasants were engaged in binding sheaves, and their daughter, aged nine, was playing near them when a storm broke with great violence.

"Let us go in, I am frightened," she cried, running to take refuge between her parents.

"We will go in immediately, but we must finish binding before the rain comes on."

"Then I will beg of the Good God to keep the thunder from us."

"Do."

And while the father and mother continued their work, the child went down on her knees, and with her hands over her eyes commenced her prayer.

Suddenly, without hearing or seeing anything, the father felt the straw move under his feet; he turned mechanically, and gave a great cry on seeing his little daughter stretched motionless on the ground. She was dead. Her little corset was unsewn and her chemise burnt.

But of all the fantastic actions of lightning, the most extraordinary and incomprehensible is the mania it has for undressing its victims, and leaving them dead or fainting in the primitive costume of our first parents —or in a dress too simple to be allowed by our civilized customs.

This deplorable and quite inexplicable habit has given lightning a large scientific *dossier*, from which we have already cited examples in the first chapter, and from which we will again extract some fragments.

Near Angers, on May 12, 1901, a farm lad named Rousteau, aged twenty-three, was killed by lightning in the middle of the fields. The corpse was found nearly naked.

On June 29, 1869, at Pradettes (Ariège), the Mayor

was unfortunate enough to take shelter under a very high poplar. Soon after he had done so, there was a burst of lightning which split the tree and struck him. In one of its diabolical freaks it entirely undressed him, throwing his various garments round about him, reduced to rags, with the exception of one shoe.

In June, 1903, at Saint-Laurent-la-Gatine, thunder broke over M. Fromentin while he was working a plough drawn by three horses. Lightning killed the leader, and completely undressed M. Fromentin after burning his hat.

The same day, at Limoges, a farm servant named Barcelot was struck under an oak. His corpse was completely naked and he had a severe wound on his left side.

On August 20 of the same year, a violent storm burst over the Isle of Re. A farmer, who was on his way to the station at Finaud, was struck fifty yards from his own house. The lightning removed all his clothes.

In 1894 the keeper of the Commune of Saint-Cyr-en-Val, near Orleans, was struck while on his rounds; the fluid deprived him of his clothes and removed all the nails from one of his shoes.

On July 2, 1903, at Aseras, near Nice, during a violent storm with hailstones 350 grammes in weight, a Mme. Blanc was on her way to meet a servant who

was in the fields. She had only taken a few steps when she was struck by lightning and completely undressed. Her body was uninjured, but the poor woman became dumb.

How fantastic and extravagant it is! It is impossible to assign any rule to the capricious advance of lightning.

How are we to explain the following facts of nature?

One night in April, at about 6 p.m., near Ajaccio, a peasant named J. B. Pantaloni was leaving the fields and hurrying home to escape from a storm. He had hardly reached his house when it was set on fire by an electric discharge, and the unfortunate man was killed dead and carbonized. At the same time his two sons and a daughter, who were in the same room, were completely undressed and their garments disappeared. These last were not hurt in any way.

Very often clothes, which have been torn and tattered, are taken a long way off.

On October 1, 1868, seven people were seeking shelter under an enormous beech near the village of Bonello in the Commune of Perret (Côtes-du-Nord), when, suddenly, lightning struck the tree and killed one of them. The six others were thrown to the ground without being much hurt. The clothes of the one who had been struck were reduced to tatters;

several of these were found hanging on the branches of the tree.

One day a workman was sheltering under the shed of a kiosque in which there were five men playing cards. He was grazed by lightning. The fluid, after having passed between the players without hurting them, left the kiosque, and removed a shoe from the poor workman, who was petrified with fright. They searched for the shoe which had been confiscated by the fulminant matter, but in vain.

Moreover, lightning seems to have a special predilection for shoes; it seldom respects them, even when it spares the other garments. Sabots, shoes, and even boots are removed, unsewn, un-nailed, cut to pieces, and thrown far away with extraordinary violence. Very often the discharge penetrates into the human body by the head and leaves it by the feet.

During a violent storm (June 8, 1868) a workman was passing near the Jardin des Plantes, when he felt a great oppression on his stomach. He was then knocked down roughly by an irresistible force, and deprived of the use of his senses at the moment of the fall. He was picked up and taken home, and on being examined, his body bore no trace of a wound, and he escaped with a fright. But some days after, when he had recovered from the shock, he remembered that he had worn boots at the time of the accident.

These had disappeared, the lightning had stolen them from him, though it acted from a distance. The boots were found in the street, and the soles had the nails completely removed, although they were screwed in and the boots were nearly new.

On May 31, 1904, at Villemontoire (Aisne), a workman was killed on a hay-cock, his clothes were reduced to fragments, and his shoes were not to be found. Two other workmen were wounded, and the cock was set on fire.

On May 11, 1893, lightning broke over the Commune of Chapelle-en-Blezy (Haute-Marne). A young shepherd, who was watching his flock in the fields, was knocked over by the fluid and lost consciousness. When he came to himself he found that his sabots and cap had disappeared.

Arago states that a workman was struck under a pavilion, and that the pieces of his hat were found embedded in the ceiling.

Biot gives the case of a hat which was flung ten paces without a breath of wind.

We could multiply these very curious observations, but we must restrain ourselves so as to remain within the limits of this little book. Did I not say just now that lightning has sometimes—though very rarely—exercised a beneficial influence on sick people it strikes?

Yes; we hear of several cases where thunder has

shown itself a rival to the noblest disciples of Esculapius, and where it has worked veritable miracles.

For instance, a person who had been paralyzed thirty-eight years, suddenly, at the age of forty-four, recovered the use of her legs, after a stroke of lightning.

A paralytic had been taking the curative waters of Tunbridge Wells for twenty years, when the spark touched him and cured him of his terrible infirmity.

Lightning has sometimes worked marvels on the blind, deaf, and dumb, to whom it restores sight, hearing, and speech.

A man who had the whole of his left side paralyzed from infancy was struck in his room on August 10, 1807. He lost consciousness for twenty minutes, but after some days he gradually and permanently recovered the use of his limbs. A weakness of the right eye also disappeared, and the invalid could write without spectacles. On the other hand, he became deaf.

Indeed, if we are to believe stories which appear to be authentic, a cold, a tumour, and rheumatism have been cured by lightning. We have given an example in our first chapter.

It is impossible to explain in what manner the subtle fluid accomplishes these wonderful cures. Are they to be attributed to the shock, to a general upheaval which brings back the circulation to its normal

course? Or are we to attribute to the electric substance—still unknown to physicians and physiologists —an action capable of overcoming the most inveterate evils?

The science of Therapeutics already makes excellent use of the electricity of the machines. Can we, then, marvel much that lightning should rival our feeble electric resources? No! What a number of services might it not render if it were not for its mad independence! What an amount of lost power there is in the gleam of lightning!

As a matter of fact, we owe no gratitude to lightning. There are too many miseries for a few happy results. The balance is really too unequal.

Some lightning strokes have proved veritable disasters, on account of the number of the victims and the havoc which has been caused.

The most extraordinary of these are the following:—

On a feast-day lightning penetrated into a church near Carpentras. Fifty people were killed or wounded or rendered imbecile.

On July 2, 1717, lightning struck a church at Seidenburg, near Zittau, during the service; forty-eight people were killed or wounded.

On June 26, 1783, lightning struck the church of Villars-le-Terroy, when its bells were being rung; it killed eleven people, and wounded thirteen.

On board the sloop *Sapho*, in February, 1820, six men were killed by a stroke of lightning and fourteen seriously wounded.

On board the ship *Repulse*, near the shores of Catalonia, on April 13, 1813, lightning killed eight men in the rigging and wounded nine, of whom several succumbed.

On July 11, 1857, three hundred people were assembled in the church at Grosshad, a small village, two miles from Düren, when lightning struck it; one hundred people were wounded, thirty of them seriously. Six were killed, and they were six hardy men.

Early in July, 1865, lightning fell on the territory of Coray (Finisterre) in a warren where sixteen people were weeding. Six men and a child were killed by the same stroke, and three others were severely wounded. Several were stripped naked, their garments being scattered in rags over the ground; their shoes were cut to pieces and all broken. A curious point is that the workers were struck at a distance of 100 yards from each other.

On July 12, 1887, at Mount Pleasant (Tennessee, U.S.A.), lightning killed nine people who were taking refuge under an oak during a storm. These formed part of a procession which was conducting a negress to her last home.

Here is another very curious and complex case—

On the last Sunday in June, 1867, during Vespers, lightning struck a church at Dancé, Canton of Saint-Germain-Laval (Loire). A deathlike silence succeeded the noise of the explosion, then a cry was heard, then a hundred more. The curé, who thought that he alone had received the whole electric discharge—and was in reality unhurt—left his place, where he was enveloped in a cloud of dust and smoke, and spoke to his parishioners from the Communion rails, to reassure them. "It is nothing," he said. "Keep your places; there is no harm done."

He was mistaken; twenty-five to thirty people had been more or less struck. Four were carried away unconscious, but the worst treated of all was the treasurer. In raising him they perceived that his eyes were open, but dull and veiled, and he gave no sign of life. His clothes were burnt, and his shoes, which were torn and full of blood, were removed from his feet.

The Monstrance, which had been exposed, had been thrown down on the ground, and was battered and pierced in the stem, and the Host had disappeared. The priest searched for it for a long time, and finally discovered it on the altar in the middle of the corporal, on a thick bed of rubbish.

Three or four yards of the wainscoting of the choir

had burnt into atoms. Outside, the arrow of the belfry had been carried off, and its slates were scattered about in the neighbouring fields.

On June 22, 1902, lightning struck the church of Pineiro (Province of Orense, Spain) during a funeral. There were twenty-five dead and thirty-five severely wounded.

These are cases of destruction on a large scale, but we can give parallel cases where the terrible fluid seems only to amuse itself.

In fact, some people appear to enjoy the privilege of particularly attracting lightning, and of frequently receiving its visits without suffering much from its reiterated attacks.

They say that Mithridates was twice touched by lightning. The first stroke was when he was in his cradle, his swaddling clothes were singed, and the scar of a burn which he received on his forehead was covered with hair afterwards.

According to the Abbé Richard, a lady, who lived in a château on an elevation near Bourgogne, saw the lightning several times enter her room, divide itself into sparks of different sizes, of which the greater part attached themselves to her clothes without burning them, and left livid traces on her arms and even on her thighs. She said, when speaking on this subject, that thunder had never done her more harm than to whip

her two or three times, though it fell pretty often on her château.

There seems to be a sort of relative immunity in women and children. These are seldom struck. We have even several examples of children remaining safe and sound in the arms of their mothers who are struck.

Fracastor's mother had her child to her breast when she was struck by lightning. The child itself was spared.

In August, 1853, at Georgetown (Essex), Mrs. Russel, wife of the Protestant minister, was killed by lightning, while a small child which she had in her arms was unhurt.

It would seem as if lightning pitied the feeble—the women and children.

We hear of cases where people were struck several times during the same storm without succumbing to its manifold attacks.

"In two similar situations," says Arago, "one man, according to the nature of his constitution, runs more risk than another. There are some exceptional people who are not conductors to the fulminating matter, and who neither receive nor pass on a shock. As a rule, they must be ranked among the non-conductor bodies that the lightning respects, or, at least, that it strikes rarely. Such decided differences could not exist without there being finer shades. Thus each

degree of conductibility corresponds during the time of a storm to a certain degree of danger. The man who conducts like a metal will be struck as often as a metal, while the man who cuts off the communication in the chain, will have almost as little to fear as if he were made of glass or resin. Between these limits there will be found individuals whom lightning might strike as it would strike wood, stones, etc. Thus, in the phenomena of lightning, everything does not depend on the place that a man may occupy; his physical constitution will have something to do with it.

The phantasmagoria of lightning leaves us perplexed. All these observations are extraordinary and very disconcerting. The facts contradict each other, and lead us to no actual conclusion.

The *Gazette de Cologne* gave the following case in June, 1867:—

At Czempin, a young girl of eighteen was struck by lightning while she was working near a hearth. She remained unconscious, in spite of all the efforts made to revive her. At last, acting on the advice of an old man, they placed her in a freshly dug ditch, and covered her body with earth, but in such a way as to avoid stifling her. After some hours she recovered consciousness, and was restored to health.

Sometimes lightning amuses itself nicely and

innocently. It mixes in the society of men without doing them harm, or leaving any remembrance but a great fear.

One day lightning entered by the chimney into the middle of a lively dance at M. Van Gestien's, the innkeeper at Flone (Belgium). At the sight of it the dancers were petrified with terror, and not one could try and escape. But they misunderstood the intentions of the lightning, which were of the most straightforward; it only wanted to be a spoil-sport. It also had the good taste to depart quietly.

After the first excitement a profound stupefaction seized hold of the persons present; they were all transformed into niggers. The lightning had swept the chimney, and cast the soot into the ball-room, powdering all the faces and toilettes.

Lightning might be the daughter of goblins rather than a messenger from Olympus. The following facts might confirm this impression :—

At Bayonne, on June 6, 1873, lightning knocked over a gas-burner, and threw a person down, after making her turn round three times. A family of twelve were gathered together at a table, sixty yards, at least, from the point where it burst. They were all knocked down, but without sustaining any injury.

During a violent storm, lightning entered a country house by the chimney; it lifted two big stones from

the hearth, and carried them over to near the head of a child who was asleep, and placed one on each side, without grazing it or hurting the child.

And this same lightning, whose almost maternal delicacy is quite exquisite, entered another time, also by the chimney, into a house, hit a man savagely on the head, wounded him severely, and left him dead in the middle of a pool of blood. Then it took a quantity of this blood which was accumulated round his head, and went and stuck it on the ceiling of the higher story. A child who was present at this tragic scene was unhurt.

In August, 1901, an electric spark penetrated into a house in the village of Porri, near Ajaccio, and started to make the tour of the property. First it visited the second-floor rooms, without doing much damage there; then it went down to the first floor, where there were two young girls, turned them round, and burnt their legs. It continued on its course as far as the cellar, where its dazzling brightness terrified three young children who had taken refuge there. It spared two, but burned the third rather severely.

Let us finish this series of electric pictures, which depict—sometimes in a very tragic manner—the different modes of activity of one of the grandest of Nature's phenomena, by two facts, the strangeness of which surpasses everything that one can imagine.

Pliny gives the case of a Roman lady, who, having been struck by lightning during her confinement, had a stillborn child, without herself suffering the least harm.

Another:—

The Abbé Richard, in his *Histoire de l'Air*, gives a more extraordinary case still. At Altenbourg, in Saxony, in July, 1713, lightning struck a woman who was expecting her confinement. She was delivered some hours afterwards of a child who was half burnt, and whose body was all black. The mother recovered her health.

We can neither define nor delimit the power of lightning. Sometimes merciful, often cruel, it constitutes in the universality of its actions, one of Nature's most terrible scourges.

CHAPTER VI

THE EFFECTS OF LIGHTNING ON ANIMALS

ANIMALS, even more than mankind, attract the fire of heaven. Lightning has a certain regard for human beings, which it seems to lose entirely when it is a case of the humble and faithful servants that Nature has given us.

And, between ourselves, thunder is not always as absurd as it appears. Its proceedings are sometimes even very tactful. Though it may often strike innocent victims blindly and ferociously; yet it seems at times to show a certain amount of intelligence. Thus we find among our many examples a strange fact, which will serve to reconcile our thoughts a little to thunder.

On June 20, 1872, in Kentucky State, we have already cited the case of the nigger Norris, who was going to be hanged for the murder of a mulatto companion, and who, just as he was putting his foot on the fatal platform, was struck by lightning, and thus spared the sheriff the trouble of hurling him into éternity.

Here was a case where thunder was full of justice, and we cannot praise it too much.

Arago gives another case where a chief of brigands was shut up in a Bavarian prison, together with his accomplices. No doubt he was encouraging their arrogance by his blasphemies—the stone to which he was attached acting as a tribune for him—when he was suddenly struck by lightning while haranguing his disciples. He fell dead. The iron manacles had brought on the disaster, but the brigands did not stop to think of this natural cause; they were just as terrified as if the iron had not been there, and the lightning had chosen its victim with intelligence.

Here is another instance—

The favourite of a prince had obtained from him a written recognition of her son. She counted on this to give trouble to the State after the death of her benefactor. She enclosed it carefully in a chest, and went and buried it deep in a wood, hoping to render all search useless, if the prince should change his mind.

But behold, the lightning intervened; the tree was struck, and the open chest was thrown on the highway, where it was found by a peasant.

Animals are worse treated than men, but better than plants and inorganic bodies. What are the causes of this difference? Can we attribute it to physical

predisposition? But this has not yet been proved. Experience shows that sparks directed on the vertebral column are particularly dangerous. Now, the backs of quadrupeds are greatly exposed to mortal strokes from the celestial fire.

Their fur or their plumage, which form an intrinsic part of their bodies, put them more or less in the situation of a man who, to protect himself from inclemency, should envelop himself in his hair, supposing this to be long enough and rich enough to cover him decently.

Animals rarely survive when struck. When they do not die on the spot, they succumb soon after to their wounds. The ancients have remarked on this.

"Man," says Pliny, "is the only animal that lightning does not always kill; all the others die on the spot. It is a prerogative granted to him by Nature, though so many animals surpass him in strength." And, further on, he adds that amongst birds the eagle is never struck. This has given it the name of *porte foudre*.

But these assertions are slightly exaggerated, and we can quote a certain number of examples of animals which have resisted the baneful influence of the electric current.

In 1901, a horse was touched by lightning, which was certainly attracted by the iron of his shoe.

It traced two deep trails right along the animal's leg, where the skin was abrased, and appeared as though it were cauterized. These two lines joined together at the fold of the ham, and then formed a single furrow, all sign of which was lost in the abdominal region. The rest of the body was unhurt, and the animal sustained no further harm after being struck than it would have done if an incompetent veterinary surgeon had fired him too severely.

On July 4, 1884, at Castres, ten persons and nine horses were struck by lightning; all survived the accident.

On June 9, 1886, in the Grand Duchy of Luxembourg, three cows and a little girl, who was in charge of them, were knocked over by a violent shock. The child and the beasts soon got up. Only an ox was killed some distance from there.

Very often horses are stunned by the discharge on animals which are killed, but after a time they recover. This phenomenon has also been observed in other animals. For instance, five or six pigs which were in a cage in the prow of a ship were killed by an electric discharge, whilst others which were only separated from them by a cloth were saved.

But the cases are rare in which animals do not succumb to lightning. They nearly always perish. At present we will only discuss animals as a body,

equal, or superior to man. The others, the smaller ones, offer a still more convincing generality.

All animals seem to be greatly exposed to the wrath of Jupiter; nevertheless, some species appear to be peculiarly sensitive to lightning—the gentle sheep, for example, which huddle together fraternally during a storm, and fall in a mass, struck by the fire of heaven.

I have before me a list of animals which have been struck. There are some of every kind. We might divide them thus—

Several hundred rams, sheep, and ewes.	3 goats.
73 horses, mares, and colts.	3 cats.
71 oxen, cows, or bulls.	3 mules.
9 dogs.	2 pigs.
4 asses.	1 hare.
	1 squirrel.

A prodigious quantity of geese, chickens, pigeons, and small birds.

Fish also contribute a respectable contingent to lightning.

As a rule, large groups of animals are dangerous when there is thunder, as they seem to exercise a strong attractive influence to the electric fluid.

Often entire herds are destroyed by lightning. Dr. Boudin gives the following example :—

On May 11, 1865, at about 6.30 p.m., Hubert

Wera, a shepherd who was surprised in the fields when a storm overtook him, was hurrying home with his flock. On coming to a narrow and difficult road, the sheep formed themselves into two groups. The shepherd took shelter behind a bush, when a terrible clap of thunder was heard. Lightning struck him and his flock. The unfortunate man was struck on the top of his head. All his hair had been taken from the nape of his neck, and the electric fluid had traced a ridge on his forehead, his face, and breast. His body was quite naked; all his clothes were reduced to rags. Moreover, there was no trace of blood. The iron of his crook had been detached from the handle and thrown several yards away, and the handle itself was broken to pieces. A small metal crucifix and a scapular belonging to the unfortunate shepherd were found fifteen yards away.

Of the flock of 152 sheep, 126 were killed. They were covered with blood, and their wounds were as varied as they were peculiar. Some had their heads chopped, others had them pierced from side to side, others had their legs fractured. As to the dog, he was not to be found.

On May 13, 1803, near Fehrbellin (Prussian States), one clap of thunder killed a shepherd and 40 sheep.

On June 1, 1826, thunder killed 64 hairy beasts in a field at Gulpin (Limbourg).

At Prades, on July 28, 1890, 340 sheep were struck at one blow.

During a violent storm which burst over Montmaur in the Isère, lightning struck a flock of 90 sheep, and killed 53.

In the month of April, 1869, thunder burst over a sheepfold in which there were 80 sheep.

Fifty of these were found entirely carbonized, the thirty others were covered with sores, on the head, in the eyes, and on the back, and half asphyxiated by the fulminant fluid. The poor sheep were all cowering together.

On August 11, 1905, a flock of sheep were carbonized, and cattle of every kind were struck.

At Limoges, on July 4, 1884, 42 cows or oxen were struck by the spark. They were all joined together by an iron chain.

On June 24, 1822, near Hayengen (Wurtemberg), a shepherd and 216 sheep out of 288, were struck in the open field.

Lastly, according to Abbadie, a storm in Ethiopia killed in one single stroke, 2000 goats and their shepherd. These figures are, I think, sufficiently eloquent, and if it were not for fear of fatiguing my readers, who might become bored, we could add a great many similar examples to this list. But it would be superfluous to expatiate further on the dangers

incurred in a storm by large agglomerations of animals. In their terror, beasts, particularly sheep, press closely together, and are soaked by the rain. In this way they offer a large surface, which absolutely conducts the lightning. Also the column of vapour which rises from these living masses, affords an excellent passage for the fluid to pass through while crossing over the bodies of the poor beasts. It would be better to disperse the flock, rather than form a compact group of them, during a storm.

One sometimes wonders also what would be the effect of lightning on animals arranged in a file. Would it act the same with atmospheric electricity as with that in our laboratories? Would the influence of the electric matter be more dangerous in the extremities than in the middle?

When lightning meets a metallic bar, it does no harm except on entering and departing. On the other hand, when several people form a chain, holding hands, if the first touches the body of a Leyden electrical jar and the last touches the top, the whole circle will instantaneously receive a shock. Only those in the middle receive a less violent one than those who touch the jar. Well, the discharges from the clouds produce similar effects on men and animals.

Arago supports this by the following facts:—

At Flavigny (Côte-d'Or), five horses were in a stable

when the lightning penetrated. The two first and the two last perished, the fifth, which was in the middle, was unhurt.

One day lightning fell on an open field on five horses in a line and killed the first and last; the three others were spared.

But we should require a much larger number of proofs before we could be sure of this.

In certain cases, lightning, always fantastic and extraordinary, seems to make a fastidious choice of its victims. It kills one, spares another, strikes a third, does good to a fourth—what a strange game! how fantastic!

Madame la Comtesse Mycielska, of the Duchy of Posen, wrote to me recently—

"During a storm which took place in the month of August, 1901, lightning entered by a half-open door into a stable where there were twenty cows, and killed ten. Beginning with that which was nearest the door, the second was spared, the third killed, the fourth was uninjured, and so on. All the uneven numbers were killed, the others were not even burnt. The shepherd who was in the stable at the time of the shock, got up unhurt. The lightning did not burn the building, although the stable was full of straw."

We have given a similar case in the chapter on Fireballs. *A propos* of this, M. Elisee Duval, of

Criquetot l'Esneval (Seine-Inférieure), relates a very remarkable case. On June 20, 1892, lightning fell on the telegraph poles of Havre and Étretat. A dozen were thrown over, and the curious part is that every second one was knocked down.

Here is a more extraordinary case still. We were not aware that thunder could distinguish between colours, and that it has its preferences amongst them. Well, we need no longer be surprised at this. Here we have a case where the fluid declares itself distinctly in favour of black. It was at Lapleau in Corrèze. One day thunder fell on a grange full of hay and straw, and covered with thatch, without setting it on fire. Then it went to the sheepfold and killed seven black sheep, and left the white alone.

This choice is categorical, and people who fear lightning might follow this example by wearing long white garments in a storm. Unfortunately, lightning is so eccentric and uncertain, that we must not defy it; it is not to be trusted.

Who can explain why it sometimes glides into a stable full of cows without injuring one? This extraordinary thing happened in the Commune of Grignicourt (Marne).

After a great clap of thunder, all the cows that were in a shed became unfastened, without one of them being hurt.

There, again, the lightning only seemed to want to make itself useful.

If, in some cases, by a providential chance, cattle have been saved, it is none the less true that an animal very rarely survives a discharge which has caused the death of a human being.

But, as there is no rule without exceptions, we will give the following :—

The sky was dark and lowering, and a shepherd, seeing that there was about to be a storm, ran to his flock to drive it to the shed. Just at the same moment, lightning burst and knocked him down, together with thirty sheep. The beasts all got up soon, but the poor shepherd was dead.

On another occasion, on June 13, 1893, a shepherd was killed by lightning, and the remarkable thing was that only one sheep out of the hundred of the flock was struck.

On June 17, 1883, thunder entered a sheepfold, containing one hundred sheep. Only four perished. One of them was marked on the back with a cross, formed of two rectilinear grooves, penetrating to the skin ; only the wool was removed.

Sometimes, but very rarely, men and animals survive the discharge.

Thus, Dr. Brillouet's horse was thrown into a ditch, and remained there without moving for three-quarters

of an hour, after which he was able to get up. Later on he became very feeble in the legs.

Very often the same stroke kills men and animals simultaneously. We have already given several cases of this kind. Here are some more—

A terrible storm burst at La Salvetat, on August 26, 1900. A shepherd and his flock, composed of twenty-three sheep, were all killed by lightning.

On June 23, 1887, a young boy, fifteen years of age, living at Montagnat (Ain), was struck while fastening oxen to the door of a stable; an ox was also killed.

At Lagraulière (Corrèze), on August 15, 1862, three girls were looking after their flocks. A violent storm burst at about five o'clock, and the thunder growled terribly. The shepherdesses, taken by surprise, had no time to take their flocks in. The two first took shelter under a big chestnut, the third under an oak twenty-five yards away from them. Suddenly lightning struck the chestnut and enveloped the two little refugees. They fell dead. The third fainted, half asphyxiated by the smell of the sulphur. The clothes of the two unfortunate girls who had been struck were burnt, their sabots were broken. Near them there were five sheep, a pig, and a she-ass, which had also been killed by the fluid. The shepherdess's dog had been cut in two.

Sometimes, also, the clap of thunder, when striking

men and animals, proves more murderous for the latter than the former, who, however, have sometimes succumbed.

A diligence was slowly mounting an incline, when suddenly a stroke of lightning interrupted its ascent. An electric ball burst over the heads of the horses, and threw the whole five down, stone dead. The postillion was struck, but not one other person was touched, though the carriage was full of women and children.

There is one peculiarity about this incident which ought to attract our attention—the terrible meteor was not accompanied by any emission of light, nor followed by any reverberation of sound.

In June, 1872, at about two in the afternoon, a farmer at Grange-Forestière was trying a couple of oxen, which he had just bought at the fair, in a field. Lightning knocked over the man and the animals. Some hours after, the poor farmer was picked up in a pitiable plight. His hair was burnt in parts, also hair on his chest, he was quite deaf, and in a state of absolute prostration. His trousers were unsewn from top to bottom in all four stitchings, his hat was riddled with holes, and his shoes torn off. All the same, he survived the accident. The oxen were killed on the spot.

In fact, as we have already said, when the spark strikes men and animals at the same time, only the former can resist the shock.

In June, 1855, thunder burst over a flock of sheep in the Commune of Saint-Leger-la-Montagne (Haute Vienne); seventy-eight sheep and two watch-dogs were killed on the spot. A woman who was looking after the flock was slightly touched.

On September 26, 1820, lightning struck a labourer who was driving near Sainte Menehould. His two horses were killed; the man escaped with a temporary deafness.

In August, 1852, two out of four oxen were killed, the third was paralyzed on the left side. As to the farmer, he came off with a numbness of the left leg.

Very often a man feels nothing, not even a shock, while the animals beside him fall dead.

Here are some facts—

On February 2, 1859, a herd of pigs were surprised by a water-spout near Liege. One hundred and fifty of these animals perished by the action of the electric fluid, their guides felt nothing.

In 1715, lightning fell on the Abbey of Noirmoutiers, near Tours, and killed twenty-two horses without doing any harm to 150 monks, whose refectory it visited and upset the 150 bottles containing their ration of wine.

In the year IX., lightning killed a horse and a mule near Chartres, sparing the miller who conducted them.

On July 17, 1895, four cows were going along a road, when suddenly they were pushed and thrown roughly to the edge of the road. The old drover who was with them felt nothing except the sensation of a strong and very characteristic odour which he could not define.

In 1812, a fulgurant discharge took place near Mr. Cowen's and killed his dog beside him, without doing him any harm.

In August, 1900, lightning penetrated into a cart-shed, where twelve chickens were taking shelter. The poor things were killed, but a lady who was feeding them was unhurt.

One often asks if lightning strikes birds in flight. This question, so often put, would seem to find an answer in the following facts:—

A lady was looking out of her window, when there was a flash of lightning, accompanied by a great clap of thunder. At the same time she noticed on the grass a dead gull which she had not seen before. The people who picked up the bird, affirmed that they found it still hot, and they added that there was a strong smell of sulphur.

Examples of this kind are rare: we have two more—

One day, Mr. W. Murdochs with two friends was looking on at a very violent storm, which spread itself over the Valley of the Ayr. Just then his dog

dislodged a flock of ducks which had been sheltered behind an old building. One of the birds began to fly, and as it was cutting through the air, it was struck by lightning and killed as though by a gun.

During a storm in the United States, Mr. Burch saw a flock of wild geese flying by. Suddenly there was a flash of lightning which threw the flock into disorder; six birds fell dead to the ground.

One would have thought that the absence of all communication with the ground ought to protect the graceful winged tribe from lightning; but no, the poor birds have received no mercy from this terrible adversary.

All the same, lightning is less redoubtable for them than the sportsman's gun. It is very seldom that the kings of the air are the victims of the fire of Heaven, but they have another enemy, barbarous, unpardonable Man. Yes, the little earthly Jupiters are infinitely more terrible for the bird-world than the giant of the gods. They are rarely softened by the seductive grace, the elegance, and the delightful twittering of the charming inhabitants of space.

In truth, one of the reasons why birds are so rarely struck in their flight is that they foresee the storm, and have the prudence to take shelter before it bursts.

Amongst birds, sparrows are those which suffer most from the electric fluid.

We sometimes find them hanging by their shrivelled

claws from telegraph wires or from the branches of trees. But this latter is rather rare. They generally nest high in the trees, and lightning affects the branches much less than the trunk.

We also hear of little caged birds being killed in their iron prison. One day a canary was in a cage with five others and was killed; the rest were unhurt. The spark was attracted by the metallic bars, and struck the canary, which was no doubt resting on iron.

Fishes in their dark dwellings are no more privileged than other animals. They also frequently receive visits from the lightning, and their sad fate has often proved how dangerous it is to remain near a pool or pond during thunder.

Moreover, why are we recommended always to put the conductor into a well, damp earth, or even into a small pond? It is because water conducts the electric substance admirably.

We can understand that a vast space of liquid would be a good refuge for lightning, when, after having made several victims on earth, and fearing the vengeance of the conductors, it hurls itself into the water.

More often it drowns itself, and in this it follows the example of the immortal Gribouille; but enough of that. The logic of lightning is still contestable.

However that may be, many examples show us the

dangers to which the denizens of rivers, and of the liquid element generally, are exposed. Not only are fishermen and sailors unanimous in attesting to the ravages wrought by lightning, but the history of electricity has preserved the recollection of memorable disasters, of veritable hecatombs of fish, which they attribute to the fire of heaven.

Arago recounts that on September 17, 1772, lightning fell on the Doubs and killed all the pike and trout which were in the river. The water was soon covered with their corpses which floated, stomach upwards.

A century before, during the year 1672, the lake in the subterranean part of Zirknitz was the theatre of a similar event, even more terrible, on account of the number of victims. The inhabitants of the neighbourhood collected such a number of fish that were struck, that they were able to fill eighteen carts.

In 1879, during a violent storm at night, the electric discharge fell on a little fish-pond in which a number of fish sported. The next morning they were all found floating dead on the surface of the water. They had the appearance of boiled fish, and their flesh fell to pieces on being touched, just as it would if it had been cooked. There was no injury to be seen, external or internal. The scales and the swimming bladder, which was full of air, had been preserved. The water of the pond remained troubled and muddy the day

after the storm, as though the agitation of the tempest had been quite recent.

Here is an observation, similar to the last :—

In 1894, lightning fell on two poplars near Ignon, in the territory of Saulx-le-Duc (Cote-d'Or). A neighbouring pond, which measured 10 yards in length by 5 in width, was also struck. The owner states that all the fish, to the number of about a thousand, were killed.

Another more curious case still :—

One day the fish in an aquarium placed in a drawing-room were struck. They were all found lying dead on the floor. The glass which formed the bottom of the vessel was twisted and coated with a thick bed of yellowish substance.

If we study the effects of lightning on animals from the point of view of the injuries which it produces, we can make some very interesting remarks.

More often the hair of animals is injured or burnt. Sometimes the spark acts on the skin over a large surface of the body of the animal. Thus, two horses had their hair singed nearly all over their bodies, and more particularly on the leg and under the stomach. At other times the hair is only burnt in certain places.

Lightning struck a young four-year-old ox which was red with white spots. It burnt and removed all the white spots and left the red hair.

But generally we find one or more furrows of different kinds. The skin is seldom intact under injured hair. It is nearly always more or less burnt. And one often notices extravasations of blood which correspond to the injuries of the epidermis, in the subcutaneous cellular tissue.

In some cases, the fulminant fluid only attacks the colour of the hair of the animal.

The fracture of the bones or the ablation of a limb is often observed on animals which have been struck.

In 1838, a violent storm broke near Nimegue, and several oxen were killed in the meadows and their bones were broken.

In the month of May, 1718, in the Marche de Priegnitz, eight sheep were struck. They could not be used as food, because all their bones had been broken as though in a mortar, and the fragments were intermingled in the flesh. These, however, remained intact.

We have seen in the preceding chapter that fulguration often leaves no particular sign on men who are struck. It is the same with animals. The electric fluid entirely absorbs the source of life and only leaves insignificant traces of its passage. Sometimes even we can find no exterior injury.

On July 7, 1779, near Hamburg, lightning killed two horses in their stable. They showed no exterior

trace of a burn, though both had a rupture of the auricles.

In the month of September, 1787, at Ogenne, two cows and a heifer were struck in their stable; no exterior wound was to be found on their bodies.

Another observation is given by the Abbé Chapsal in his remarkable description of the effects of lightning. A pig fell dead, struck by a clap of thunder, and no indication could be found of the electric passage.

We see that lightning does not always make a great distinction between the blows which it inflicts on men and those which it inflicts on animals.

Sometimes, also, the corpses of beasts which are struck are completely incinerated. At the first sight, the body appears intact, but when you touch it, it falls to pieces.

At Clermont (Oise) on June 2, 1903, several animals were entirely carbonized in their stable.

We have also heard of animals being transported by the meteor a long way from the place of the catastrophe. Others have suffered from grave nervous troubles, following on the strokes of lightning which they have received. Sometimes partial or total paralysis results. Thus, a cow which had been struck by lightning, was knocked over, and remained a quarter of an hour motionless, after which it was seized with violent convulsions, then it got up quickly looking terrified.

Here is a case of a severe shock which brought on an access of delirium.

In the course of a terrible storm on September 4, 1849, a butcher, accompanied by a dog, took refuge under a beech at the edge of the road. Suddenly lightning fell on the tree and struck the dog, which became mad, and threw itself on its master, bit him in the thigh, and only let go when the butcher dragged the animal with him into a neighbouring house and cut his tail. The dog died in the night.

There are some examples of injuries wrought on animals which are barely perceptible. For instance, when it makes a transparent horn, opaque, and when it burns the mucous membrane of the nose.

On the other hand, the foetus which sleeps under the frail covering of the egg, is exposed to the pitiless blows of the most terrible meteor, as is the baby in its mother's womb. Chickens have often been struck before they ever saw the light of day.

Often the noise of thunder, and the fear which results from it, causes the miscarriage of hinds, and particularly of lambs.

An animal which has been struck generally sinks instantly, without a struggle. All the same, we hear of the case of a horse which was struck by the flame, and which struggled for a long time against an inevitable death.

The corpses of animals, like those of men, are sometimes very rigid; at others they are soft and flaccid, and decompose rapidly.

Thus all the sheep of a flock which were together under a tree in Scotland, were killed by a great clap of thunder. The next morning the owner, wishing to get some advantage out of their remains, sent his men to skin them, but the bodies were already in such a state of decomposition, and the stench was so abominable, that it was impossible for the servants to execute his orders. They hurried to bury the sheep in their skins.

On September 10, 1845, at about 2 p.m., lightning fell on a house in the village of Salagnac (Creuse). Amongst other accidents it killed a pig in a stable; three hours after the body was completely decomposed.

When animals are killed, not by the atmospheric fluid, but by the lightning of our machines, decomposition always comes on very rapidly.

Brown Sequard made the following very curious experiment on this subject:—

He took the hearts away from five rabbits of the same kind, the same age, and about the same strength. He put one aside without touching it, and he submitted the four others to the passage of an electric current, of a different strength for each animal. Here are the different results obtained—

The first animal became rigid after ten hours, and its rigidity, which was excessively marked, lasted eight days. The rigidity of the four others was feebler, and lasted a shorter time in proportion to the strength of the electric current. Thus, the one which received the weakest current, became rigid at the end of seven hours, and this lasted six days. The one which received the strongest current became rigid in seven minutes, and its body softened after a quarter of an hour.

This experiment explains the absence, or the shortness in duration, of corpselike stiffness in subjects which have been subjected to the terrible discharge of lightning.

Animals are not only the frequent victims of lightning, but, as this experiment shows, they are still oftener the martyrs of science. Laboratories are sometimes transformed into small cemeteries, where lie poor guineapigs, frogs which have been quartered, and mutilated rabbits. But what is the ordinary lot of these last when science spares them? The chief point is not to let the innocent victims suffer.

Can we eat with impunity the flesh of animals which have been struck? Several people say Yes, many say No. Both are right.

Putting aside the question of the rapid putrefaction to which these bodies are nearly always subjected, the

flesh of animals killed by fulguration has often been found unhealthy and uneatable.

A veterinary surgeon who was commissioned to examine the bodies of two cows and an ox which had been struck in a stable, declared that their flesh could not be eaten without danger.

On the other hand, Franklin recounts how some people ate fowls which had been killed by the electric spark—"this funny little lightning"—and cooked immediately after death. The flesh of these capons was excellent and particularly tender, and the illustrious inventor of lightning-conductors concluded by proposing that we should follow this proceeding in order to ensure our fresh meat being as clean as possible when served at table.

We think, however, that it is more prudent to sacrifice the meat which has been struck, as it has been proved that in certain cases the decomposition is very rapid.

Up to now we have seen all animals, man included, as victims of lightning: it is the general rule.

Nevertheless, we often meet beings in this world, men, animals, or plants, which try to distinguish themselves from others by some sort of originality. This appears to be the case with the electric fish, whose existence seems to be dedicated to the worship of Jupiter.

These curious fish have received the gift from Nature of being able to hurl lightning to a certain distance.

This is how they set to work. A little fish in search of food goes too near this terrible enemy, who at once sets his living tail in motion. Fascinating it with his eye, he renders it immovable, and lets fly repeated discharges to it. After a minute, the poor fish is overcome, and allows itself to be snapped up by its pitiless adversary without resistance.

Certain rivers in Asia and Africa and the depths of the Pacific Ocean, in which these curious animals live, are often the scenes of terrible dramas, caused by the presence of these lightning fish, which are divided into five species: the tetrodon, the trichiure, the silurus, the raie torpille (cramp-fish), and the gymnote (electric eel). These aquatic lightnings work terrible havoc among the inhabitants of Neptune's kingdom. They use their influence over men as well as fish. If you touch a torpille, you feel a shock strong enough to benumb and paralyze the arm for some minutes.

A curious experiment was tried: eight people formed a chain, and one of them, with a piece of metallic wire, touched the back of a torpille which had been imported. They all felt the shock.

If thunder had elected to be domiciled anywhere

but in its own clouds, it would seem as if it would be in the organism of these curious fish.

Unfortunately, in our international relations, humanity has invented a much more dangerous torpille (torpedo)!

CHAPTER VII

THE EFFECTS OF LIGHTNING ON TREES AND PLANTS

NEARLY two thousand years ago, Pliny wrote, "As regards products of the earth, lightning never strikes the bay tree." And this is why the Roman emperors, in fear always of the fire of heaven, crowned themselves with laurels. This belief was almost universal in ancient times, and survived for many centuries.

But every new century has proclaimed the immunity from lightning of some one member of the vegetable world, though impartial research has now established the fact that there is no such absolute privilege. If certain trees are rarely struck, that is, perhaps, due less to its species than to its size, its hygrometrical condition, and to other influences which it is still difficult to specify; for lightning, as we have seen, has capricious habits which we have not yet succeeded in explaining.

Thus the bay tree has lost its proud position in this respect, and has had to take its place amongst the ordinary run of trees, subject to the unjust anger of

Jupiter. Many bay trees of some size have been seen to fall victims to the electric fluid.

The fig tree, the mulberry tree, and the peach tree have also been reputed to enjoy safety, but this also is not the case. There is an instance on record of a fig tree being struck by lightning and completely withered, and another of a mulberry-tree, eighty years old, being partly destroyed.

In our own days, the beech is believed to go uninjured. In the State of Tennessee, in the United States, the opinion is so deeply rooted that beech tree plantations are often resorted to as a refuge in times of storm. But it would be a mistake to place too much trust in them. There are records of beech trees being struck by lightning and destroyed, just like bay trees, fig trees, and the rest.

In 1835, an old beech tree was struck in the forest of Villers-Cotterets. This venerable patriarch was more than three hundred years old. Of its upper branches, which were wide and strong, four of the finest were destroyed ; a fifth, stripped of its bark to a great extent, was not torn off the trunk. The trunk was split where the other four branches were torn from it. The interior of it was blackened and slightly carbonized.

On July 15, 1868, at Chéfresne, canton de Percy (Manche), an oak and an ash were struck by lightning within five minutes of each other.

On August 10, 1886, at Haute-Croix, in Brabant, an ash was struck and destroyed. On August 23, in the same year, an ash was struck also at Namur.

The box tree and the Virginian creeper used to be regarded as safeguards against lightning. The same virtue was attributed to the house-leek, a thick herbaceous plant, which grows usually upon walls and roofs, and which the Germans call Donnerblatt or Donnerbarb, Thunder-leaf or Thunder-beard.

According to some authors, again, lightning never strikes resinous trees, such as pines or firs. But this also is disproved by the facts, especially in regard to firs.

Among the many particulars I have collected of recent years, is the following list of sixty-five different kinds of trees, with the record of the number of times each species has been struck by lightning within a given period :—

54 oaks.	2 lime trees.
24 poplars.	2 apple trees.
14 elms.	1 mountain ash.
11 walnut trees.	1 mulberry tree.
10 firs.	1 alder.
7 willows.	1 laburnum.
6 pine trees.	1 acacia.
6 ash trees.	1 pseudo-acacia.
6 beech trees.	1 fig tree.

4 pear trees.	1 orange tree.
4 cherry trees.	1 olive tree.
4 chestnut trees.	0 birch.
3 catalpas.	0 maple.

Height obviously accounts for a good deal. It is incontestable that, in the case of a clump of trees standing in the middle of a plain, lightning will in most cases pick out the tallest. But this is not an absolute rule. The isolation of trees, their qualities as conductors, the degree of moisture in the soil in which they are rooted, their distance from the storm clouds, the character of their foliage and of their roots—all these things are important factors.

Numerous experiments have been made with a view to ascertaining the amount of resistance offered to the electric spark by different kinds of wood. Similar pieces of beech and oak have been exposed lengthwise to the electric spark given out by one of Holtz's machines, with the result that the oak wood was pierced by the electric fluid after one or two revolutions of the machine, whereas for the beech wood a dozen or twenty were needed. Black poplar wood and willow offer a moderate resistance: a few revolutions suffice to penetrate them.

In all instances the susceptibility of the wood depends on the sap. It has been proved by analysis that the woods which contain starch with but little oil,

such as the oak, poplar, willow, maple, elm, and ash, offer much less resistance to the electric current than those trees which are richer in fatty matter, as the beech tree, walnut tree, lime tree, birch tree, and so on.

These conclusions are corroborated by the case of the pine tree, the wood of which has a great quantity of oil in winter, but in summer lacks it as much as those trees which contain more starch.

Experiments have proved that in summer this wood is quite as likely to serve as a conductor as the oak; while in winter its resistance to the electric spark equals that of the beech and other trees which are rarely struck by lightning. Decayed trees are excellent conductors of electricity; those in full vigour being much more rarely struck.

In any case, it has been proved that the effects of lightning are particularly severe in the vegetable world. It has been pointed out elsewhere in this little book to what dangers those persons are exposed who take shelter beneath the trees during a thunderstorm; there are innumerable examples of the imprudence of taking refuge from the rain under thick foliage, people having been killed by a fireball—for lightning does not always take the trouble to make a selection, sparing neither the protector nor the protected.

We shall give some more instances, chosen from a considerable number of similar observations.

In 1888, ten reapers, surprised by drops of rain and distant rumbling of thunder, left their work and took refuge beneath a big walnut tree. But one of them having questioned the security of this retreat, all immediately fled in the direction of a neighbouring wood, except one young girl of fourteen years. Several who returned to advise her to follow them, saw her smilingly throw her arms round the trunk of the tree, and almost at once fall backwards, her arms extended. She was dead.

On the 22nd of August in the same year, four labourers, returning from work, were overtaken by a thunderstorm. Three of them stopped under an elm, the fourth prudently continued on his way. Well it was for him. Several minutes later, the lightning struck the tree, killing two of the labourers outright, and grievously wounding the third. The latter was found almost completely naked; his garments, burnt and tattered, were scattered round him. When he came to himself, he was in such a violent delirium that it was necessary for several men to bring the unfortunate victim to his home, where he died shortly afterwards in the most horrible agony.

About six o'clock, on the 23rd of June, seven men employed on the farm of Puy-Crouel, were working in a field of beet-root. Overcome with the heat, they went into the shade of a walnut tree. All at once,

a flash of lightning illumined the sky; the seven workmen were thrown down, one of them being hurled several yards away. Three of them were able to get up and go to the farm, the others were severely burnt, and half asphyxiated. One of the victims had his back skinned the whole length of the vertebral column; the other had his face scratched, as if torn by finger-nails. All had lost their memory. The walnut tree under which they had sheltered was cleft from top to bottom.

Here is another example no less terrible—

Seven children, belonging to Ahrens, were caught in a thunderstorm as they were coming home from the fields, and took shelter under a tree. The lightning killed the seven little people.

Another time, four young men taking refuge under an oak, were struck and thrown down. One of them was killed instantly, his companions were cruelly injured.

On the 10th of July, in Belgium, a woman gathering cherries was killed on a tree which attracted the fluid. A young man standing beneath it was paralyzed.

We might multiply these tragic tales; each year a number of similar cases happen. The imprudence of human beings is truly incorrigible!

Everybody, however feeble his instinct of self-preservation, should flee the vicinity of trees during

a thunderstorm, and allow himself to be drenched on the road, rather than offer his life as a too generous burnt-offering to the lightning, for the oak's robust trunk, or that of the poplar, elegantly plumed with its graceful foliage, may be the altar on which the sacrifices in honour of Jupiter are made.

The wood of trees is not so good a conductor of electricity as the human body. For this reason, a person leaning against a tree receives the full discharge; at times the tree is splintered, because it did not serve as a perfect conductor.

Yet the conductive power of certain species is so remarkable, that the neighbourhood of particular trees may be regarded as a protection against lightning (this, however, without coming in contact with them !).

The tips of the branches pointing towards the clouds, and the moisture they receive, undoubtedly influence the electricity of the atmosphere; and, moreover, by means of these graceful branches, an inaudible but continual exchange is effected between the electricity of the earth and sky, thus holding the balance between two opposite charges.

Colladon asserts that poplars planted near houses may, in favourable conditions, act as lightning conductors, on account of their height and powers of conducting. He adds that it is necessary to take other circumstances regarding the situation of the

dwelling into account, which are not always easy to define. Their protection of the neighbourhood is not constantly the same. For it to be effectual, the foliage should be very low, and they should be at least two metres distant from the roof and walls. Their roots, too, should be in a damp soil, and metal should not enter largely into the construction of the neighbouring houses. In these conditions, poplars may fulfil the useful functions of lightning conductors.

At times, during a storm, several trees are struck by the same flash. For instance, on May 23, 1886, in Belgium, three poplars were blasted by a single thunderbolt.

On the other hand, trees planted in lines are sometimes struck alternately. A case occurred where the lightning seemed to have taken aim and touched all the odd numbers in a row without striking the others.

Certain plantations act on the fluid with an extraordinary intensity.

At Lovenjoul, in Belgium, a wood of undergrowth and big trees, planted in marshy ground, seems to possess this singular privilege, and the agriculturists of the country declare that no storm ever passes their way without lightning falling there. In the middle of this wood one can count seven oaks, near to one another, struck by it. Not far off, a huge ash, and a little farther away two poplars, likewise blasted.

All the trees have not been struck in the same way; some are scorched or stripped of their leaves; the others have their trunks perforated, or split in different parts. Usually trees are cleft from top to bottom; in some cases the furrow is horizontal or perpendicular in the direction of the branches.

Pieces of bark or of wood are sometimes torn off lengthwise, and only adhere to the trunk in strips here and there. But that does not prove conclusively that the lightning struck upwards from the ground; it may have rebounded (?) after striking from above.

Certain effects, however, can only be explained by an ascending movement of the fluid. The following cases for example:—

"During the summer of 1787, two men were sheltering under a tree at Tancon, Beaujolais, when they were struck by lightning. One of them was killed on the spot, the other felt no ill effects other than momentary suffocation. Their horses were caught up to the top of the tree. An iron ring which bound the wooden shoe belonging to one of the men, was found hanging from a high branch of the same tree. Now, at a little distance, there was a tree which had also suffered greatly by the passage of the electric fluid. In the soil at its base a round hole was to be seen, shaped like a funnel. Directly above it the bark had been loosened and slit into slender thongs. As for the

tree beneath which the men had sheltered, it also had half its bark off, and long splinters were to be seen hanging only by the upper parts. On one side of the tree the leaves were withered, on the other they were still quite green."

In this most remarkable instance the lightning had come out of the ground.

In the cleft of a willow tree blasted by lightning its roots were found.

Besides, the soil is often undulating, and thrown up around trees which have been struck.

Vegetables do not always succumb, any more than men, to these attacks. They may be lightly struck in a vital part, in which case they recover from their wounds. Very often they are merely stripped of their natural garments, in other words, of their bark and foliage. This is one of those superficial injuries to which they are most subject.

The following is an example of this kind of fulguration :—

On July 16, 1708, two oaks were struck at Brampton. The larger measured about ten feet around the base. They were both split asunder, and the bark peeled off from the summit to the soil, a length of twenty-eight feet. Completely detached from the trunk, it hung in long strips from the top.

Boussingault witnessed the destruction by lightning

of a wild pear tree at Lamperlasch, near Beekelleronn. At the moment of the explosion an enormous column of vapour arose, like smoke coming out of a chimney when fresh coal has been put on the fire. The lightning flashed in all directions, great branches gave way, and when the vapour cleared off, there stood the pear tree, its trunk a dazzling white: the lightning had taken the bark completely off. Sometimes the bark is only partially stripped off one side, or left on, in more or less regular bands, either on the trunk or on the branches.

During a violent storm at Juvisy, on May 18, 1897, an elm five hundred metres distant from the Observatory was struck by lightning, which took the bark off lengthwise in a strip, four centimetres wide and five centimetres deep. This band of bark was cut clean off. There was no trace of burning.

Sometimes only the mosses and lichens are whisked off the sides of the trees, which escape with light scratches. Two great oaks which had been struck by fireballs, only bore traces of two punctures which might have been made by small shot.

Moreover, it is not uncommon to see the bark riddled with a multitude of little holes, like those made by worms.

Two men were struck by lightning near Casal Maggiore on August 15, 1791, beneath an elm tree.

One of them had his elbow on the tree at the moment, and amongst other injuries were a number of little holes in the arm. There was a twist in the tree at the part where the elbow rested, and a hole penetrated the centre of it to the core of the wood. The surrounding bark looked as if it had been mite-eaten. Several scars started from this point and ascended almost perpendicularly towards the top of the trunk. There was no damage done to the branches.

Lightning cut through a chestnut tree, five metres high, on the roadside at Foulain (Haute-Marne), burning several leaves, then struck some water-pipes at a depth of a metre and a half, and finally passed into the dike through two holes a metre deep by a decimetre in diameter.

The bark is often reduced to thin splinters scattered on the soil, or hanging from the neighbouring trees, or even thrown to a considerable distance.

On June 25, a fireball fell near Jare (Landes) on a pine tree, which it shivered into a myriad slender strips, about 2 metres long, many of which were caught on the branches of pines within a distance of 15 metres. Only a stump, $2\frac{1}{2}$ metres in height, remained standing. At the same time three other pines, which stood 18 and 25 metres away from the first, were destroyed. The bark had been stripped off each, but only as far as the incision made for extracting the resin.

Furrows, of varying width, and running in different directions, may at times be seen on trees, some short, others reaching to the top of the tree, and occasionally to the roots. These marks show the passing of the lightning.

Sir John Clark has seen a huge oak in Cumberland, at least 60 feet high and 4 feet in diameter, from which the lightning had stripped a piece of bark, about 10 centimetres wide and 5 centimetres thick, the whole length of the trunk in a straight line.

The furrow is not always single, it may be double, and either stretch in two parallel lines or diverge.

The Chevalier de Louville observed in the park of the castle at Nevers, a tree struck at the top of the trunk by lightning which, dividing in three shafts, hollowed three furrows that might have been made by three rifle shots fired towards the roots. These three furrows followed the irregularities of the trunk, always slipping, gliding between the wood and the bark, and curiously enough the former was not burnt.

But these bands are not invariably straight either; in the above example they followed the caprices of the vegetable body. They are to be found oblique in certain cases, but more often they surround the trunk in long spirals of varying width, showing that the lightning clasped the tree in the form of a serpent of fire.

Here is an example:—

During a violent storm on July 17, 1895, a poplar was blasted on the road through the forest of Moladier, 160 metres north-west of the castle of Valliere. The tree was 25 metres high, and in full leaf from base to summit; it was struck halfway up by the discharge, and a spiral furrow 10 centimetres wide twisted round the trunk to the ground.

I noted a similar case, August 25, 1901.

Lightning struck one of the highest trees in the park at Juvisy, a magnificent ash, stripping off and destroying the bark where the electric fluid curved round and round down the full length of the trunk, which was shattered by the meteor a few metres above the roots. Enormous fragments lay all round the trunk, some hurled to such a distance that it was obvious the explosive force of the phenomenon must have been of extraordinary violence.

I was able to trace the course of the lightning to the foot of the tree, along its roots to a great depth, by a black furrow.

The tree is not dead. The ivy which clung to it is dead.

The vast and splendid forest of Saint Germain often witnesses the presence of the lightning, and the magnificent trees which adorn and beautify this charming and celebrated place are, unfortunately,

too often the victims of these inopportune visitations.

Lightning has no respect for old memories. It demolished with a single flash a superb giant whose long branches, laden with perfumed leaves, had given shade to many generations. The splendid tree, which had survived the severity of several centuries, fell beneath the arrow of the pernicious fluid. Such was the fate of an oak near l'Etoile du Grand-Veneur. Struck on the top, its upper branches were violently torn off. . . . A spiral furrow beginning at the top ended within a metre of the ground. But, wonderful to relate, the whole mass of the tree appeared to have been twisted mightily by a force which worked with so much power that the tree could never regain its original position. The fibre, instead of growing vertically, followed the furrow made by the lightning, and became twisted like a corkscrew. There exist certain singular trees, the fibre of which grows in spiral fashion, and is called twisted wood by carpenters and cabinet-makers. Pines and firs in mountainous countries are fairly often affected in this curious fashion. One can no more account for it than one can define the cause of the curved form of some flashes of lightning. One does not know exactly if they should be attributed to their following the direction taken by the fibre, or whether, on the contrary, the

tree had been struck in its infancy by a spiral flash, and, submitting to that influence, continued to grow up corkscrew fashion.

It is most probable that the fall of the thunder-ball on the trees in this manner is governed by the laws of electricity. We may even note casually that traces of similar spirals have been remarked on objects as well as on the dead bodies of those struck by lightning, thus preserving the ceraunic likeness of the mortal blow.

Other observers, besides, have declared that they saw distinctly the spiral lightning flash through the atmosphere. But these observations would need to be confirmed by photographs of indisputable accuracy. In these circumstances, as in many others, the dark room is worth a hundred human eyes!

In some cases the curved furrow turns several times. For instance, in May, 1850, Grebel saw an alder nearly twenty metres high struck by lightning on the right bank of the Elster below Zeitz. On the lower part of its trunk were two spiral bands which had carried away bark and sap-wood, leaving no trace of combustion.

The depth and width of the twist are very variable; at times the furrow is deeper in the veined parts than at the edges; again it reaches the core.

Two oaks were struck in June, 1742, in the park at Thornden. One was marked with a spiral for a length of forty feet to within a little distance of the ground.

The band was five inches wide, but became narrower as it descended, and was finally no more than two inches wide. The wood was incised and even torn in places, but the branches were not hurt. The rest of the bark seemed to have been riddled by small shot.

All the injuries of which we have spoken (excoriation, stripping off the bark, furrows), are not necessarily mortal. But there are other more serious wounds from which the tree rarely recovers. We allude to deep fissures and breaks produced by lightning. When the fracture touches only a portion of the topmost part of the tree, the result of the accident is not necessarily fatal. But this is not always so.

On May 14, 1865, a poplar was split in two by lightning at Montigny-sur-Loing. One half to the full height continued standing. The other half was chopped up in small fragments and thrown to a distance of a hundred metres. These pieces, which were brought to me by M. Fouché, are so dried up and fibrous that they might be taken for hemp instead of wood.

In the majority of these cases the tree is split from top to bottom.

On July 5, 1884, in Belgium, a poplar, the biggest of a group of trees of the same species, was struck and split down its full length.

In the month of August, 1853, on the side of the

road from Ville-d'Avray to Versailles, a poplar of about twenty years old was cleft from the topmost bough to its roots; one half remained in its place, the other fell on the road. A black line, about a millimetre wide, ran down the centre of the tree.

Sometimes the tree is divided into several parts by vertical fissures. For example, in 1827, near Vicence, a pear tree, three feet in diameter, was split into four parts, from the top down.

How often one has remarked great tree trunks in the forests, decayed and desolate, standing sadly, like poor headless bodies? Very often lightning has been the executioner of these trees.

In the month of May, 1867, in the forest of Fontainebleau, a magnificent oak, about two metres in circumference, was completely decapitated by lightning; its branches fell on the ground. The part of the trunk left standing was barked to the roots and splintered into fragments of varying sizes. They were scattered on the ground or hung from the branches of the surrounding trees. Several pieces of considerable size were hurled more than thirty metres away, much to the injury of the bark of the trees which they struck.

In numerous cases, the tree struck by lightning is broken in several places, and fragments of it thrown far and wide.

On July 2, 1871, at the farm of Etiefs, near Rouvres, canton of Auberive (Haute-Marne), lightning struck an Italian poplar, sixty years old, thirty metres high, and three metres round at a height of one metre from the ground, splintering off enough wood to make a heap sixty-five centimetres round, and fifty centimetres high.

An ash was struck by lightning on July 17, 1895, on the road to Clermont. This tree, ten metres high, was broken at a point $3\frac{1}{5}$ metres from the ground, and the crown, still hanging by a shred from the trunk, lay on the embankment. The violence of the explosion threw pieces thirty centimetres wide and $3\frac{1}{2}$ metres in length, into a field from twenty-five to thirty metres off.

On July 4, 1884, in Belgium, a willow was reduced to a heap of atoms on the ground. In March, 1818, at Plymouth, a fir more than a hundred feet high and forty feet in circumference, the admiration of the countryside, disappeared, literally shattered into bits. Some fragments were thrown two hundred and fifty metres away.

One of the most curious effects of lightning is to divide the interior of the tree into concentric layers, fitting them perfectly one into the other, but at the same time separating them with extraordinary precision.

Arbres roulés (thus are the trees called which are victims of this odd phenomenon), as a rule, do not show any injury on the outside. But the body, dissected by the electric fluid, soon succumbs.

An oak, twenty-five metres high, having been struck on August 25, 1818, was opened to be examined carefully, and it was stated that the concentric layers were as detached from one another as the tubes of an opera-glass.

The fireball sometimes hollows a canal through the centre of the trees from the top to the bottom, the sides of which are burnt black. The following is a curious example:—

In June, 1823, at Moisselles, lightning fell upon a great elm, and striking against an enormous knob, rebounded on to a neighbouring elm half its own height, pierced it through and through, shivering it to tatters; the trunk was burst open to the roots, it looked as if it had been bored through from one end to the other by a red-hot bullet that blackened and charred it.

Does it not seem as if the lightning plays with the lives of the trees as with man? It threatens, changes, apparently spares, returns to the charge and finally annihilates. And this sport is accompanied, at times, by inconceivable effects.

But records are still more eloquent than reflections:

Nature, in her own mute speech, tells us of a thousand marvels.

Is not the following phenomenon enough to make lightning more mysterious in its fantastic and varied mode of action?

On the 19th of April, lightning struck an oak in the forest of Vibraye (Sarthe), cut this tree, measuring a metre and a half in circumference, at two-thirds of its height, pulverized the lower parts, strewed the shreds over a circuit of fifty metres, and planted the upper part exactly on the spot from which the trunk had been snatched, with all the rapidity of a flash.

Moreover, the annual concentric circles were separated by the sudden drying up of the sap so effectually, that, the strips only remained welded together where the knots made too great an obstacle to their separation.

How was the lightning able to plant in the earth, with such inconceivable rapidity, the top of the tree where the roots had been? This is something which no one can explain. It alone is capable of creating such situations.

But it has done better still! Two years later, in 1868, it took the opportunity of playing a good trick on two trees of different species, an English oak and a forest pine, which, without race jealousy, fraternized in the forest of Pont-de-Bussière (Haute-Vienne). These

two trees were about ten yards apart, and were simultaneously hit by the explosive matter, and in the twinkling of an eye, their leaves were changed. The pine needles found themselves on the oak, and the leaves of the oak went to brighten the austerity of the pine with their delicate verdure. There was nothing commonplace about the metamorphosis. Accordingly all the inhabitants went in crowds to the scene of this miracle to contemplate the unusual spectacle of a pine-oak and an oak-pine.

And the unexpected happened: both trees appeared to thrive very well in these new conditions: the pine continued to be agreeably adorned with its festival foliage, whilst the oak agreed perfectly with the sombre needles of the pine.

After such marvels, my readers will not be surprised to learn that lightning sometimes shatters the living wood, or decayed wood, into a thousand morsels without setting it on fire.

For instance, a bundle of faggots lying on the hearth has been reduced to atoms by lightning, without any trace of combustion being visible.

A fireball fell on a sheaf of barley in the open field without setting it on fire, and buried itself in the ground without doing other further damage.

In certain cases the electric fluid chars wood at varying depths: the blackened layer is often very

slight; sometimes, on the contrary, combustion is complete.

As for the leaves, they are unhurt as a rule. When they are attacked they shrivel up; an autumnal shade takes the place of their charming green tints; they turn brown and dry up quickly.

One of the trees in the Champs-Élysées having been struck, it was proved that all round it the ground was full of little holes. In two or three places the bark was raised from beneath; the leaves were yellow and shrivelled up as parchment would be by the fire; the upper part remained green. Everything seemed to prove that the lightning came out of the ground.

At other times the same effect may be observed on the leaves, when the trunk and roots are apparently uninjured. It is not unusual to see the tree instantly stripped of its leaves as if by some mysterious power.

The lightning acts also on the roots, as we have seen in the preceding examples. They have been seen uncovered where the ground was much disturbed, torn in strips, or cleft in more or less regular pieces.

We see that lightning does not make more ado about exhaling its baleful breath on the life of plants, than on animals and men. And moreover, that it often strikes these latter with sudden death without leaving a trace of its passing, just as sometimes it strikes the trees without leaving any exterior injury. Now and

then life is not completely extinguished, and little by little the tree recovers its health. Often the vitality is not changed, one sees the tree which was struck bear fruit as before the catastrophe.

Has it not been asserted that lightning may exert a benign influence on vegetation?

This was the opinion of the ancients.

A propos of this, Pliny said, "That thunder is rarely heard in winter, and that the great fertility of the soil is due to the frequency of thunder and rain in spring; for the countries where it rains often and in good earnest during the spring, as in the island of Sicily, produce many and excellent fruits."

It has been proved in our times that the ancients were right in extolling rainwater as nourishment for the products of the earth, and science has discovered the cause to be the presence of great quantities of nitrogen and ammonia in the thunder-rain and in hail. Perhaps electricity has a similar effect.

In the neighbourhood of Castres, on April 13, 1781, an old poplar was stripped of its bark in several places. Now, shortly afterwards it burst into leaf, although the neighbouring poplars were much later than it.

The ravages caused in the fields by the electric meteor to forage and vegetables are sometimes considerable. This is especially so with grass when cut,

to haycocks, ricks of straw, barley, etc. We have a collection of records of men or animals who, when leaning against haystacks, were struck.

As a rule the haystack is burnt; sometimes, however, the grass is simply scattered and thrown to a distance.

In 1888, a very curious occurrence was observed at Vayres (Haute-Vienne).

The lightning struck a field of potatoes at the village of Puytreuillard; some of the stalks were burnt to cinders; but most remarkable of all, *the potatoes were done to a turn*, just as if they had been cooked beneath hot ashes.

A belief which was very general in ancient times and derived without doubt from a recollection of the circumstances which were said to accompany the birth of Bacchus, gave the vine the privilege of protecting the neighbourhood from the fatal effects of lightning. But this again is only a legend. The following observation proves it:—

On July 10, 1884, at Chanvres (Yonne), fifty vine-stocks were frizzled up by lightning.

It used to be supposed, too, that the electric fluid held the lily in particular respect. But here is a note which shows us that the white flower is visited by the burning flashes. During a violent thunder-storm on June 25, 1881, at Montmorin (Haute-Garonne)—— But let M. Larroque, who witnessed the curious

phenomenon, describe it: "In a clump of lilies in my garden," says he, "I see the highest of them surrounded by a violet glimmer, which formed an aureola round the corolla. This glimmer lasted for eight or ten seconds. As soon as it disappeared, I went close to the lily, which, to my great surprise, I found had been deprived of its pollen, while the surrounding flowers were laden with it. So the electric fluid must have scattered or carried off the pollen."

When Jupiter thunders, he still seems to dominate our world, as in the days when the graceful legends of mythology flourished.

And not only does he work above ground, but, contrary to the belief of the ancients, his influence extends beneath the soil.

A great number of men were working in the mines at Himmelsfurth on July 5, 1755. They were, as often happens, working at various points along the vein of metal, and never dreaming of the events which might take place on the surface of the ground. All at once they were conscious of several very violent shocks, given in the oddest and most extravagant fashion. Some felt the shock in their backs, while their neighbours received them on their arms or legs. They might have been shaken by a mysterious invisible hand, stretching now up from below, now from above, now from the sides of the galleries. One of

the miners found himself hurled against the wall, two others, whose backs were turned, almost came to blows, each believing that his mate had thumped him.

The real culprit was the thunder, of whom they might well demand an explanation of these strange proceedings.

Here is another example which bears out the foregoing:—

On the 25th of May, the watchman on guard at the pit mouth of one of the principal mines at Freyberg, perceived an electric glimmer run along the wire rope going to the bottom of the mines, and used by the miners to exchange signals with the men employed in working the lifts. Suddenly all the pits were brilliantly lit up. At the same moment the watchman saw a clear vivid flame shoot out at the other end of the chain. On this occasion the lightning behaved with due discretion, and shone through the mine without giving any one the slightest shock.

In vain the monster Tiberius, and the infamous Caligula, sought a subterranean refuge from lightning. Their impure consciences, laden with crimes, dreaded the chastisement of heaven. By fleeing from the lightning flash, they believed themselves saved from death. Lightning dogs our footsteps, and works even when the criminals believe themselves in safety. It is conceivable that the ancients should have dreaded it as an instrument of celestial justice.

Usually lightning strikes the ground with a vertical stroke, but at times obliquely, when it traces long, horizontal lines. Often the ground may be seen turned up at the foot of trees which have been struck, the sod is torn, and stones thrown to a great distance. Sometimes, too, an excavation may be seen in the ground near the object struck, of varying breadth and height. This opening may be like a funnel or hemispherical.

In a case observed on June 6, 1883, at Côte (Haute-Saône), a circular hole, having a depth of 1·20 metres, has been seen in a dyke on the declivity of the road, below a coach which was not struck.

Occasionally the hole is but the beginning of a canal, hollowed rather deeply and perpendicularly in the ground, the sides of which serve as a sheath to the fulgurite. But before treating of fulgurite tubes, which constitute the most curious phenomena in the world connected with lightning, we shall discuss certain remarkable effects observed on the surface of the ground.

Falling on solid rocks, the electric spark can break them, cut them, or pierce them in one or more places. Often instead of spoiling or cutting off pieces of the stone, it covers the surface instantaneously with a vitreous coat, having blisters of various colours. This vitrification is often to be seen on mountains.

De Saussure found rocks of schistous amphiboles covered with vitreous bubbles, like those seen on tiles where struck by lightning. Humboldt made similar observations on porphyritic rocks at Névada de Toluca, in Mexico, and Ramond, at the Sanadoire rock in Puy-de-Dôme.

In these cases, the spark, on reaching the surface, melts it more or less completely over a varying extent, and this fusion, worked upon by an extraordinary heat, produces a coat having a peculiar appearance, but in which microscopical analysis finds the elements of the body it covers.

Thus the vitreous layer deposited over chalk is of chalky origin; that covering granite is of the nature of granite, etc.

This does not apply to certain deposits found on rocks, and even on trees, which have been struck by lightning, and which are of very different origin.

Whilst the former is only the stone in a fused or vitrified condition, the latter is caused by the presence of foreign bodies, some fragments of which have been detached by the ray and travel with it. This transport of solid substances by lightning has often been observed. Here are two examples of this strange phenomenon:—

On July 28, 1885, at Luchon, on the Bigorre road a passer-by saw lightning fall twenty yards away

from him. Recovered from the shock, he went out of curiosity to look at the result, and saw the wall at the edge of the road, the schistous and chalky rocks, even the trees themselves, coated over with layers of brown. It was certainly a case of the lightning having effected a deposit. This latter was very curious. Lines could be traced on it with the finger-nail, it fell to powder under slight pressure, became soft with gentle rubbing, caught fire from a candle, and then gave off a resinous odour with much smoke. What is this resinous matter? That is what no one yet can say.

In the month of July, 1885, on the day following a violent thunderstorm which had struck the telegraph-office in the station of Savigny-sur-Orge, I myself picked up a little black powder off the telegraph poles, which had been left by the lightning, and which had a sulphurous smell.

The production of this ponderable matter has often been attributed to bolides, but direct observation proves beyond a doubt that the electricity carries various solid substances found on earth after a storm.

Lightning is truly the most venerable of glass-makers. Long before the most remote peoples of antiquity appeared, whose glasswares encrusted with marvellous iridescent tones by the passing of the centuries, are unearthed by scientific excavations, and displayed in national collections; long before man

could have learnt to make use of the resources of nature, lightning, burrowing in the sand, there fashioned tubes of glass that hold the hues of the opal, and are called fulgurites.

The ancients seem to have known of these fulgurite tubes, but we owe the first precise description and the first specimen of these extraordinary vitrifactions to Hermann, a pastor at Massel in Silesia. His fulgurite, found in 1711, is in the Dresden Museum.

Since this discovery, fulgurites have often been sought for and found. The tubes, contracted at one end, and ending in a point, are to be seen in sandy soils.

Their diameter varies from 1 to 90 millimetres, and the thickness of their sides from half to 24 millimetres. As to the length, it sometimes exceeds 6 metres. Vitrified inside, they are covered outside with grains of sand agglutinated and apparently rounded as if they had been subjected to a beginning of fusion. The colour depends on the nature of the sand in which they have been formed. Where the sand is ferruginous the fulgurite takes a yellowish hue, but if the sand is very clean, it is almost colourless or even white. As a rule, the fulgurites penetrate the ground vertically, Nevertheless, they have been found in an oblique position. At times, also, they are sinuous, twisted, or even zigzag if they have met with pebbles of considerable size.

It is not uncommon for the fulgurite tube to divide in two or three branches, each of which gives birth to little lateral branches of 2 or 3 centimetres long, and ending in points.

There are also solid fulgurites and foliated fulgurites. The former, no doubt, had a canal originally, which has been stopped up by matter in fusion. The latter, instead of being stretched out in cylindrical form, are composed of slender layers like the leaves of a book.

The scientific museum at the Observatory of Juvisy possesses a very curious fulgurite which was offered to me some years ago by M. Bernard d'Attanoux, and found by him in Sahara. It is not a tube ending in a point. The lightning penetrating the sand, vitrified it on its passage, and branched irregularly in three principal directions. One might say it was slag formed by the juxtaposition, irregular and crumpled, of three blades of vitrified sand, which would be pressed together by leaving a narrow opening to their central vertical axis. This fulgurite, which is extremely light, measures six centimetres in length. It was found in the sand of Grand-Erg, at a depth of several centimetres. It has been found possible to produce miniature fulgurites by means of our electrical machines. By adding ordinary salt to the sand, and directing a strong current into it, complete vitrification of a tube of several millimetres is obtained.

CHAPTER VIII

THE EFFECTS OF LIGHTNING ON METALS, OBJECTS, HOUSES, ETC.

When lightning strikes the earth, it makes straight for metals. Their perfect conducting powers place them in the first rank of conductors, and the innumerable cases of lightning with which they are associated have gained them a certain celebrity in the annals of thunder.

We know, indeed, the preference of the spark for metals; we know it nurses a veritable passion for nails, wire, bell-pulls, that it dotes on rain-spouts, leaden pipes, and telegraph wires, that it is very feminine in its adoration of jewels, which it sublimates sometimes with a truly fantastic dexterity.

Now and then lightning deviates from its path, and performs acrobatic feats, elfin capers to reach the objects it covets. On April 24, 1842, it struck the church of Brexton, springing on the cross of the steeple at first and running down the stem, but, arrived at the masonry which supported it, broke it into pieces;

then with one bound it fell upon a second conductor, whose support was also broken. Finally, it struck a third conductor much lower down.

The fluid often searches for metals hidden beneath non-conductors, which it breaks or pierces. It avoids the mattress to pursue the iron of the bed, glances off the windows to glide over the curtain-rods, or the lead of the sash. It has been seen to penetrate thick walls to reach the iron safes hidden behind them.

We have already mentioned the case of the woman who, without having been killed, had her ear-ring split. Well, we have a certain number of similar examples to that.

On June 1, 1809, in a boarding-school for young ladies, at Bordeaux, a gold chain, worn by one of the young ladies, was melted by the lightning, which left a black indented line in its place, which, however, soon passed off. The lady was struck, but recovered consciousness within a few hours, being none the worse. Her slender chain, worn in three rows round her neck, had been cut into five pieces. Some of the fragments showed signs of fusion, and had been carried to a distance.

Other examples, in which the consequences were more dramatic, will show ladies the dangers of a love of adornment.

On September 21, 1901, during a violent

thunderstorm which burst over the region of Narbonne, a fireball fell in the domain of Castelou. A young girl of fourteen was fatally struck by the meteor. The gold chain which she wore round her throat was completely evaporated. There was not a trace of it to be found.

It is not unusual to see gold chains broken, melted, partially or completely, in the pocket which had held them.

Thus, lightning melted a watch and chain into a single lump in the pocket of a man killed on board a passenger boat.

Bracelets, hairpins, and even precious stones are sometimes very strangely altered.

As for watches, without speaking of the magnetization observed after a violent electrical discharge, it has been remarked that the movement became slower. In some cases they stopped short, and marked the exact instant when the lightning stopped them.

When the ship *Eagle* was struck by lightning, none of the passengers were injured, but all their watches stopped at the moment the shock took place.

At other times there are peculiarities in the works which are absolutely inexplicable. The following observation, related by Biot, is a curious case in point.

A young man was slightly struck by lightning in the street of Grenelle-Saint-Germain. His watch was

in no wise hurt outside, but, although it was only a quarter-past eleven, the hands pointed to a quarter to five.

Convinced that it was in need of repair, the young man placed it on his table, intending to take it to the watchmaker; but next day, thinking he would wind it up to make sure of the extent of the damage, he saw, to his amazement, the hands moved and kept regular time.

In some instances the case of the watch is seriously injured, while the works are none the worse.

A man wore a watch with a double cap attached to a gold chain. The chain was broken, some of the links soldered together. The cap had been perforated, and the gold spilt in his pocket. The watch itself had not been altered.

But if lightning sometimes stops the works of watches, it also produces the contrary effect.

Beyer relates that a flash of lightning, having entered a room and broken the corner of a glass, set a watch going which had been stopped for a long time.

I find the following note amongst my papers: "M. Coulvier-Gravier, director of the meteoric observatory of the palace of Luxembourg, told me yesterday that on Sunday, April 8, at 9.35 in the evening, a watch (wound up), which had stopped a week previously, went on at the moment lightning struck the

lightning conductor on the Luxembourg above these rooms."

Often enough the case is badly injured: the polish is rubbed off the metal, it is melted, bored through, and even dented, without any trace of fusion.

A case of the latter is rare. Here is an example, however.

In the month of June, 1853, a man from Aigremont having been killed by lightning, his silver watch was found in his watch-pocket completely smashed.

Indeed, one of the most common effects of lightning on watches is the magnetization to which the various pieces of steel are subjected. We have a considerable number of records concerning these magnetic properties. In one case the balance had its poles so well pointed that, when placed on a raft, it served as a compass.

We may observe, by the way, that clocks and chronometers are sometimes as much injured also by the spark. It often gives an energetic twist to the needles, or to the spring for regulating the strokes, or it even melts the wheel-works, either partially or completely.

It is difficult to form any idea of the various operations of lightning; here it hurls itself down like a fiery torrent, there it makes itself so tiny that it can pass through the smallest apertures.

Does it not even slip under women's corsets, melting the busks and the little knobs which serve to hook them.

It even attacks the various metal articles which set off our garments, even to the shoe-buckles, buttons, etc.

Keys are, as a rule, very ill-treated by the fire of heaven: they are twisted, flattened, melted or soldered to the ring from which they hang.

On May 12, 1890, a man living at Troyes returned to his house while a violent storm was raging. The moment he put his key into the lock, the white gleam of a dazzling flash of lightning surrounded him, the ring holding his keys was broken in his hand, and they were scattered on the threshold.

At times, too, scissors, needles, etc., are snatched out of the hands of the workers, and carried some distance off when they are not reduced to vapour.

At Saint-Dizier (Haute-Marne) in July, 1886, lightning fell on the workshop of M. Penon, a chain-maker. Five or six workmen were finishing their work or getting ready to leave.

Entering by the window near which M. Penon—who was absent at the time—usually worked, the fluid grazed the bellows which were opposite, and caught up a piece of it, which one would have thought was cut off with a knife. Turning to the left, and passing behind a chain-maker, who felt a violent shock, it passed to a heap of chains which it did not damage much. All the links in a chain of about a metre long were, however,

soldered together; the whole chain seemed to be galvanized, and the soldering was not easily broken by hand. Pieces of iron which had been cut and prepared for the manufacture, were found twisted and soldered together in the same way. Finally the lightning snatched the iron hoops from a tub, and, returning the same way, broke a piece of wood from a board, so as to go through the lower part of a partition, the masonry of which was carried away for a length of fifty centimetres.

Very often lightning rivals the most skilful cabinet-makers: iron or copper nails are pulled out of a piece of furniture with a most amazing skill, without doing any harm to the material they kept in place. Ordinarily they are thrown far away. Here are two examples of this curious phenomenon:—

On September 23, 1824, lightning penetrated a house at Campbeltown; the copper nails in the chairs were pulled out very precisely, without the stuff being spoiled. Some were conveyed to the corner of a box standing at the opposite end of the room, others were so solidly fixed in the partitions, that it was only with great difficulty that they were pulled out (Howar). At another time, close to Marseilles, lightning slipped into a drawing-room, one might say, like a robber, one evening, and pilfered all the nails out of a couch covered with satin. Then it departed by the chimney

through which it had entered. As for the nails, they were found, two years afterwards, under a tile!

Locks, screws, door-knobs are frequently pulled out by the fluid.

Sometimes metal objects of much larger size, such as forks or agricultural instruments, share the same fate. Violently torn out of the hands of their owners, they start upon an aerial voyage, borne on the incandescent wings of the wrathful lightning.

Workers in the fields have often been warned of the dangers to which they expose themselves beneath a thundery sky, by carrying their implements with the point in the air. Each year the same accidents occur in precisely similar circumstances.

The electric fluid, invited by the metal point which acts like a little lightning conductor, darts from the clouds upon this centre of attraction, and runs into the ordinary reservoir by the intermedial body of the man, who plays the *rôle* of conductor.

Two labourers were spreading manure in a field, when a storm came on. It was at the beginning of May, 1901. Obliged to give up work, they were thinking of returning home. Each carried an American fork over his shoulder. They had come within 150 metres of the village, when a formidable burst of flame took place over their heads. Instantly the two labourers fell, never to rise again.

In 1903 I made notes of several cases of this kind, from which I shall quote the two following:—

On June 2, a labourer from the hamlet of Pair, commune of Taintrux (Vosges), aged forty, was sharpening a scythe in an orchard close to his house. Suddenly a terrific clap of thunder was heard, and the unfortunate man fell down stone dead.

On the following day, in the same region, at Uzemain, not far from Epinal, a young man, twenty-eight years of age, went to get grass in the country. All at once he was struck by lightning, and his horse, which he was holding by the bridle, as well. The poor fellow had been guilty of the imprudence of putting his scythe on the cart with its point in the air.

On May 27, in the Vosges, the lightning fell on a labourer, Cyrille Bégin, who was driving a cart to which were yoked four horses. The unhappy man was struck, as well as two of the horses.

Some authorities have attributed a doubly preservative influence to umbrellas. The first is undoubtedly to shelter us from the rain; the second, more doubtful, is the gift of preserving us to a certain extent from the strokes of the terrible meteor. Silk, having the property of a veritable repulsion to lightning, one might really believe that umbrellas, whose covers are often made of this fabric, are protectors against the fire of heaven. But the records which we possess are

not conclusive; if, now and then, the discharge becomes distributed by means of the ribs, it also very often happens that it runs along the metal parts of the handle to whatever pieces of metal may be on the person, finally striking the soil through the human body.

On July 13, 1884, in the province of Liége, a man and a woman sheltering under the same umbrella were struck by lightning. The man was killed instantly. His garments were in tatters, and the soles torn from his shoes. His pipe was thrown twenty yards away, as well as the artificial flowers in his companion's hat. The latter, who was carrying the umbrella, was stunned.

At a season when, as a rule, thunder is not dreaded —December 9, 1884, to wit—two men, who were walking on either side of a schoolboy holding an umbrella, were killed by lightning. The child was merely thrown down, and got off with a few trifling wounds.

In each of these cases, the person who carried the umbrella suffered less from the electric discharge, but did not escape altogether, nevertheless. It may be remarked, also, that the chief victims were just under the points of the frame, and that in all probability the electricity passed through these points.

The fusion of metals is one of the lightning's most

ordinary performances; it has occurred at times in considerable quantities.

On April 2, 1807, a fulminant discharge struck the windmill at Great Marton, in Lancashire. A thick iron chain, used for hoisting up the corn, must have been, if not actually melted, at any rate considerably softened. Indeed, the links were dragged downwards by the weight of the lower part, and meeting, became soldered in such a way that, after the stroke of lightning, the chain was a veritable bar of iron.

How, one asks, can this truly formidable fusion take place during the swift passage of the electric spark, which disappears, it may well be said, "with lightning speed."

What magic force gives the fiery bolt from the sky the power to transform the atmosphere into a veritable forge, in which kilos of metal are melted in the thousandth part of a second!

Great leaden pipes melt like a lump of sugar in a glass of water, letting the contents escape.

In Paris, June 19, 1903, lightning broke tempestuously into a kitchen, and, melting the gaspipes, set fire to the place.

On another occasion, the meteor breaking into the workshop of a locksmith, files and other tools hanging from a rack on the wall were soldered to the nails

with which the iron ferrules of their handles came in contact, and were with difficulty pulled apart.

A house at Dorking, Sussex, received a visit from lightning on July 16, 1750. Nails, bolts, and divers small objects were soldered together in groups of six, seven, eight, or ten, just as if they had been thrown into a crucible.

"Money melts, leaving the purse uninjured," says Seneca. "The sword-blade liquifies, while the scabbard remains intact. The iron in the javelin runs down the handle, which is none the worse."

We could add other examples, quite as unheard of, as those enumerated by the preceptor of Nero.

A hat-wire melted into nothing, though the paper in which it was wrapped was not burnt.

Knives and forks were melted without the least injury being done to the linen which enveloped them, by the presence of the fluid.

These proceedings give proof of exquisitely delicate feelings; it is a pity the lightning does not always behave in the same way.

Wires, and particularly bell-wires, make the most agreeable playthings for the lightning, judging from the frequency with which they are struck.

Sometimes, in the middle of a fearful thunderstorm, the doorbell is violently rung; the porter rushes to open the door for the impatient visitor, only to receive

a shock of lightning by way of salvo. The mysterious hand which pulled the bell is already far away; but it has left its impress on the bell, and the guiding ray follows the metal wire in all its windings, passing through holes no bigger than the head of a pin. The wires are often melted into globules, and scattered around in all directions.

The Abbé Richard has seen globules from a bell-wire fall into coffee cups, and become embedded in the porcelain, without the latter being any the worse.

Metal wires supporting espaliers and vines are often compromising to the safety of their neighbourhood, especially when they are against a house.

Without renouncing the succulent peach, or the golden chasselas grapes, propped on espaliers, we ought to see that they are so arranged that they do not act as lightning-conductors to our habitation.

In August, 1868, in a farm amongst the mountains near Lyons, lightning fell at a distance of about fifteen metres from a dwelling where there were four people; the meteor, conducted by the wire supporting a vine on a trellis, followed it into the house, and knocked the four people down.

One could almost believe that lightning takes a certain pleasure in looking at its diaphanous and fugitive form in the mirrors hung as ornaments in our drawing-rooms.

In 1889, a very coquettish flash of lightning rushed to a mirror, breaking more than ten openings in the gilt frame. Then it evaporated the gilding, spreading it over the surface of the glass, while on the silvered back the evaporation of this latter metal produced the most beautiful electric traceries.

Sometimes the tinfoil or pieces of melted glass are thrown to a great distance; and at times the fusion of the glass is so complete that the *débris* hangs down like little stalactites.

As for the gilding of the frames, it is often carefully removed by the lightning to a distance, and applied to the gilding of objects which were never intended to receive this style of decoration.

It is just the same with the gilding on clocks, cornices, church ornaments, etc.

There are innumerable examples coming under this category. Here are a few:—

On March 15, at Naples, lightning flashed through the rooms of Lord Tylney, who was holding a reception that evening. More than five hundred were present; without any person being injured, the lightning took the gilding clean off cornices, curtain-poles, couches, and door-posts; then it shook its booty in a fine gold dust over the guests and the floor.

On June 4, 1797, lightning struck the steeple of Philippshofen in Bohemia, and went off with the

gold of the clock, to gild the lead in the chapel window.

In 1761, it went into the church of the Academical College in Vienna, and took the gold from the cornice of one of the altar pillars to put it on a silver vase.

It seems difficult for lightning to resist the attraction of gildings. It was reported that when a house in the Rue Plumet in Paris was struck in 1767, among several frames hanging in a room, the spark only touched one which was gilt. None of the others were struck.

In spite of this extraordinarily independent behaviour, lightning has not so much liberty of action as we might be tempted to believe; it obeys certain laws which are not yet defined, and its gestures, although apparently wild and capricious, are not the result of fortuitous circumstances. To allude to it as chance may serve as a refuge from ignorance, but it does not, any more than we can, explain the extraordinary phenomena.

Why are certain organic or non-organic bodies visited repeatedly by lightning? We need not have recourse to magic to explain.

It is simply because they serve as favourable conductors for the fluid. One of the best-known examples of this kind is that of the church of Antrasme. It was struck by lightning in 1752. It melted the gold of the

picture frames adorning the sanctuary, blackened the edges of the niches in which the images stood, scorched the pewter vases enclosed in a press in the sacristy; then, lastly, it made two very neat holes at the end of a side chapel, by which it took its departure. The traces of this disaster were removed with all haste, but twelve years later, on June 20, 1764, the lightning returned to the charge. It penetrated the church for the second time, but the most remarkable fact is, that it worked havoc similar to that done on its first visit. Again the sacred picture-frames were despoiled of their gilding, the niches of the saints blackened, the pewter vases scorched, and the two holes in the chapel re-opened. What demon guided the lightning in these scenes of pillage? The end of the story gives us the clue. Soon after the catastrophe the use of the lightning-conductor became general throughout the whole world. The church was put under the protection of a rod of iron, after the principles of Franklin, and ever since lightning allows the faithful to pray in peace within the sanctuary, and has never returned to profane the church at Antrasme.

Such incidents are of fairly frequent occurrence; they give us a chance of understanding the supposed preferences of lightning.

In the last chapter we shall see curious cases of "galvanoplasty," of the nature of the following:

amongst others, that of a piece of gold in a purse, which was silvered over with silver taken out of another part of the purse, through the leather of the compartment.

What a trick of prestidigitation! On our music-hall stages this turn would have a great success.

But our last word has not been said about lightning. Just a few more.

One of the most curious effects produced on metals, is the magnetic polarity communicated to objects in steel and iron, no matter what they be. We have already quoted a remarkable case, that of the ascending lightning.

A tailor was slightly touched by the spark; the day after the accident he found his needles were magnetized: they clung closely to each other as they were taken out of the case.

Another case of magnetization has been recorded, where certain objects, which were struck by lightning, had power to raise three times their own weight.

This magnetization is almost always temporary. Examples are known, however, where objects preserved the magnetic powers that they acquired in the moment of the shock. And one can understand the terror inspired by lightning in uncultured minds, when, after the passing of the meteor, they see common things suddenly animated by a fantastic vitality, fine needles

attract and raise very much larger bodies than themselves, and impart a feverish agitation to any pieces of steel or iron that may be placed near them.

What a lively impression these curious phenomena must have made on the minds of men in the days when sorcery was in fashion, and when lightning was, according to the belief then popular, at the service of heaven and hell! But, nowadays, sorcery is fallen into disuse; the magnetization of metal bodies, even when the result of lightning, is something too well known to be attributed to any connection with Satan.

And yet the gambols of electricity are truly extraordinary.

In the month of June, 1873, the electric fluid penetrated into a butcher's shop, quite calmly followed the iron bars from which the quarters of meat were hanging. From one of the hooks a whole ox was suspended. All at once the skinned carcase was galvanized by the electric current, and during several instants it was seen convulsed by the most frightful contortions.

Again, on June 28, 1879, a concierge in the Avenue de Clichy was sweeping his courtyard when the lightning broke at one metre above his head. The poor man escaped with the fright. The fluid ran up the leaden pipes and entered a room, where it broke the mirrors and a clock, injured the ceiling, and got off by

breaking the panes in the window. On the upper storey it got into a lodging occupied by two old women, where it caused the following damage: one of the women was holding a bowl of milk, the bottom of the bowl was cracked and the milk spilled on the floor; some money which was in a wooden bowl disappeared and could not be found. The clock was stopped at half-past six, the pendulum unhooked; and a hole made in a glass globe the size of a five-shilling piece. Finally, a woman in bed on the same landing saw the bed split in two by the lightning, which disappeared in the wall. None of these persons were injured.

As a general rule, indeed, when lightning breaks into houses, although it often does a great deal of harm, it almost always spares the people who may be there. One is safer there than anywhere else.

Sometimes the walls are pierced or merely hollowed. This perforation of the walls is one of the most common effects of the meteor on buildings.

The thickness of the perforated walls is very variable.

At the Castle of Clermont, in Beauvaisis, there was a formidable old wall, built in the time of the Romans, so tradition has it, which was ten feet thick, and the cement was as hard as stone, so that it was almost impossible to break it. "One day," says Nollet, "a

flash of lightning struck it, and instantly a hole, two feet deep and equally wide, was made in it, the *débris* being thrown more than fifty feet away."

On June 17, 1883, at Louvemont (Haute-Marne), the wall of a bakehouse, fifty-five centimetres wide, was broken in by lightning.

The church at Lugdivan was struck by lightning in 1761. Two furrows like those made by a plough were to be seen on the wall.

One of the most dreadful acts of which lightning is capable is that of hurling considerable masses of stone and rock, broken or intact, to great distances. We have numerous examples of this terrible phenomenon. Here are a few :—

On August 23, 1853, thunder burst over the belfry of Maison-Ponthieu. The explosion scattered the slates and beams of the roof, and shot a stone, measuring thirty-five centimetres, to a distance of twenty metres. Rough stones, weighing more than forty pounds, were torn up and thrown almost horizontally as far as an opposite wall thirty feet away.

At Fuzie-en-Fetlar, in Scotland, towards the end of the eighteenth century, lightning broke, in about two seconds at most, a mica-schist rock of one hundred and fifty feet long, by ten broad, and in some parts four feet thick ; this it split into great pieces. One, measuring twenty-six feet long by ten broad, and four in thickness,

fell on the ground twenty centimetres off. Enormous stones are thrown, at times, in different directions.

In 1762 lightning struck the belfry of Breag Church in Cornwall, broke the stone pinnacle of the edifice, and threw one of the stones, weighing at least a hundredweight and a half, on the roof of the apsis, in a southerly direction, fifty-five metres away.

In a northerly direction another huge stone was found at 365 metres or so from the belfry; and a third, still larger, to the south-east of the church.

In certain cases the lightning unites a fantastic skill with this excessive brutality. For instance, a wall has been removed intact without being broken in any part. Here is a record of one such extraordinary occurrence:—

On August 6, 1809, at Swinton, near Manchester, during a deluge of rain, the lightning all at once filled a brick building, in which coal was stored, full of pestilential, sulphureous vapour. Above it was a cistern half full. Suddenly the edifice, the walls of which measured thirty centimetres in thickness, were torn out of the ground, the foundations being sixty centimetres deep, and was transported in an upright position to a distance of ten metres.

The weight of this mass, so oddly and so rapidly moved by lightning, was estimated at ten thousand kilograms.

In many cases, on the contrary, the subtle fluid has

pulverized a hard stone on the spot and reduced it to powder.

Tiles and slates are very often torn off the roofs: the lightning makes them fly through the air. Sometimes it is content to perforate them with a multitude of little holes.

As for chimneys, they are generally very ill-treated by the meteor. The blows of which they are victims are to be accounted for easily, for they offer perfect powers of conducting to the fulminant matter, firstly, because of their prominence on the summit of the building, especially when they are surmounted by a vane. Again, the flue is often in cast-iron, and if it is bricked it is supported by bars of iron. The surface of the interior is covered with a layer of soot, an excellent conductor, and a stove-pipe often opens into it. Then, too, the hearth and its surroundings are more or less made of metal. Finally, the column of smoke and of hot, damp air rising into the air, shows the lightning the way.

The latter often accepts this invitation, and very frequently gets into a house by the chimney, where everything seems ready for its reception.

Rafters and doors are sometimes bored through with one or two holes by the spark, and split or furrowed more or less deeply. A curious fact is that it is rare to find the slightest trace of combustion round them.

In the month of August, 1887, lightning struck the belfry of the church at Abrest (Allier), carrying off part of the roof.

It destroyed the walls of the porch, and in both sides of the swing doors bored two holes, each as big as a pigeon's egg, and as symmetrically as if they had been made by the hand of man.

The cleavage of beams is amongst the most extraordinary injuries to be observed on woodwork. Lightning works with wrought wood just as it does when the tree is in full sap: it reduces it to rags, and follows the direction of the fibres.

With what crimes lightning is charged! When it is a question of robbing a house, it spares nothing in its way.

The window-panes fly in pieces, and sometimes are thrown a long way off. Often they are melted and disappear totally.

In July, 1783, at Campo Sampiero Castello (Padua), lightning struck a building full of hay; the windows had glass in them, and the panes were melted *without the hay catching fire!*

A still more astonishing phenomenon is that of the total disappearance of the glass panes, observed at the Castle of Upsal, on August 24, 1760. Lightning visited this edifice and then took flight, carrying off sixteen panes out of a window. Not the smallest fragment of them was ever found.

Perhaps, as often happens, terrific heat was generated, and the glass evaporated.

If we follow the track of lightning through rooms, very singular effects may be seen on the furniture. Chests of drawers and wardrobes are gutted, and the contents pulled out and strewn about the room. In the middle of August, 1887, a house at Francines, near Limoges, was struck by lightning. It fell in a room where the master of the house was in bed. He felt a terrific shock, and saw his eiderdown pierced through and through by the perfidious fluid, and a chest of drawers with all its contents broken. Continuing on its way, the lightning demolished the door and entered another room.

A man who was asleep in it was killed. His wife by his side and his little girl felt nothing, but *a pillow on which one of them had her head was thrown to a distance.* Finally, the meteor went through the floor, broke a large clock on the ground floor, setting fire to everything on its way.

On June 1, 1903, a fulminant ray fell on the church of Cussy-la-Colonne (Cote d'Or). To start, it turned the clock tower upside down, broke a clock, then opened a cupboard in the sacristy in which there were various articles, and broke them all.

In April, 1886, lightning did great damage in the church at Montredon (Tarn). It demolished the

steeple to an extent of three metres, several bells, and carried the enormous iron bar which supported them a long way off. The roof of the church was burst in and the tiles were pulverized in several places by the falling masonry. In the interior a bench was broken, an image of Christ reduced to powder, and a metal image of St. Peter twisted.

We may remark, by the way, that churches are very often struck by lightning, doubtless owing to the height of the steeple above the edifice.

We have innumerable notes about ruined steeples, turrets knocked off, the plundering of priestly objects. Sculptures and pictures adorning the sanctuary are often destroyed, and the altar itself shattered. Cases of priests struck while officiating are not uncommon. As for the faithful killed while at church, they may be counted by the hundred.

Without wishing to call lightning a miscreant or an infidel, one is obliged to confess it fails in respect for holy places.

However, the quips and cranks of lightning observed in dwellings are no less varied and curious.

Here are some remarkable accounts :—

One night during a terrible thunderstorm, lightning came down the chimney of a room where two people were asleep. The husband awoke with a start and, believing the house to be on fire, groped his way

to the mantelpiece to get a candle, but was stopped by a heap of rubbish. Everything, in fact, of which the chimney had once consisted was heaped up in the middle of the room. The mantelshelf, violently torn off, had been partly melted, the clock had had the door of the case pulled off, and all the window-panes were broken. On the lower storey, another clock was similarly demolished, the floor was torn up and the tiles thrown with such force against the ceiling that there were splinters sticking all over it.

In the month of April, 1866, at Bure (Luxembourg), the thunder, which had been rumbling for some time, suddenly crashed down all at once about midnight with the most appalling violence, so that the ground seemed to tremble and the houses rock on their foundations.

All the inhabitants, aroused in terror; instinctively several of them sprang out of bed, thinking that their dwellings must be annihilated. Every one had the presentiment of disaster, which was only too real: the fluid had just struck the house of a poor workman, and left a scene of frightful destruction behind it.

The roof had been carried off, the chimney destroyed, the windows reduced, so to speak, to atoms, the principal door smashed and hurled to a distance; of the furniture there was nothing left but shapeless wreckage. But what was most extraordinary is, that this catastrophe only cost the life of one person, while

all that were in the house might well have been killed.

Three children, sleeping in an upper storey, found themselves thrown outside the house without knowing how they got there, but *safe and sound*, though the bed was broken to pieces. The father and mother were asleep on the ground floor, with two little children, one of whom was at the breast. This latter was flung out of his cradle and thrown against the wall, without being hurt.

At this moment the mother sprang out of bed to succour those dear to her, but while the poor woman was in the act of lighting a candle, the lightning struck her lifeless on the floor. The husband, who was in the bed with another child, only felt a severe shaking. The lightning, having accomplished its work of destruction, finally broke an opening in the lower part of the wall, went into the stable adjoining the house, and there killed the only cow that was in it.

In the month of August, 1868, at Liége, Rue du Calvaire, at the point where the mountain of St. Laurent is highest, lightning first of all struck two earthenware chimney-pots which were higher than the roofs. One of these pots was thrown to the ground and broken, the other disappeared. Then the electric spark ripped off a great part of the roof. All the tiles were scattered round the house. A young servant

slept in a garret under the roof; the lightning penetrated into the garret through a little hole in the wall just above the head of the maid's bed; the latter was flung into the middle of the room without the slightest bruise, though the wood of the bed was bored through in two places.

From there, the spark going through the wall again, went down to the ground floor, following the gutter pipe, which it broke. It re-entered the house by making a little hole in the wall, pulled off the plaster which was round two nails holding up a mirror, broke part of the frame; again left the room, entered a little room adjoining where six people were sleeping—the father, the mother, and four young children; pierced the wall to enter a locksmith's, scattered all the tools, tore out a drawer, broke it into a thousand pieces, and threw the contents on the floor, broke all the panes of glass; again went through the wall, went to a hutch with a rabbit in it, killed the animal, and at last went into the garden, where it dug a double trench several feet long.

The house was occupied by two families of ten persons, none of whom were struck. Terrified by the report they rose instantly; the smell of smoke filling all the rooms told them of the danger they had just escaped.

On another occasion one sees the woodwork of the

chimney burnt, as well as a press, a looking-glass, and a clock badly injured by the lightning; which before retiring, and by way of being a good joke, turns a felt hat upside down, and unscrews the andirons.

Examples of this kind are very numerous. We constantly speak of the caprices of the lightning, but what name could one give to anything so burlesque or incomprehensible as the following:—

In the month of July, 1896, lightning fell in the village of Boulens, on a cottage almost covered with thatch. Entering through the chimney, which it destroyed, it first threw down a rack, pulling out the hinge which held it up, and making in the place of the said hinge a hole right through the wall. Afterwards it lifted a pot and the lid from the hearth over to the middle of the floor, tearing up some tiles as it went. It broke the latch of the hall door, as well as the key which was in the lock; this latter was found afterwards in a wooden shoe which was under the sideboard. Two canes that were beside the mantelpiece, were laid on the said mantelpiece as if placed there by hand.

A meat chopper and a copper basin used for ladling water out of a pail, and attached to either end of the stove, were likewise thrown into the middle of the room. But the oddest part was that these two articles were fastened together, the twine which served to hang up the chopper being rolled round the handle of the

basin. Finally, the flash divided, and zigzagged off, one part carrying off a piece of the oak jamb of the hall door, the other part piercing a hole above the stove in a mud wall. Through this it threw fragments of laths and mortar into a window eleven metres off, near which two people were sleeping.

This little dance, in which so many and various articles took part, does not lack piquancy!

This is how lightning joins in the National Fête of France!

On July 14, 1884, in the village of Tourettes (Vaucluse), lightning struck a house, carrying off a corner of the roof. It knocked off the lower part of the roof, and broke through a wall at least fifty centimetres thick.

In a press built half into the wall, and in which there were about fifteen bottles containing various kinds of liqueur, only one bottle of spirits was broken, and this was done in such a manner that no trace could ever be found either of the glass or the liquid.

From thence it sprang to the pictures hanging above the head of a little girl of five, who was sound asleep. Three pictures were torn from their frames, engravings and mirrors were ground to powder, but the child was not hurt. Then the electric current made an opening in the ceiling, which was about forty-five centimetres thick, broke a great many tiles as it

left the house, but soon returned by way of the chimney, three parts of which it demolished. Then it explored the kitchen on the ground floor, where there were three men by a fire. One, standing up, was thrown violently against the opposite wall; another was hurled against the door; the third, seated, was raised from his chair to a height of at least fifty centimetres, and then dropped. To crown all, the spark tore away half the butt-end of a gun, and carried it into the next room, where there were eleven people who got off with nothing worse than the fright. Then going up the chimney, it exploded at a height of 1·50 metre, throwing bits of plaster and of the pothanger in all directions.

What frantic and almost childlike fury!

Yet somewhere else the very brother of this ray may caress the little head of a sleeping child, and not do it the slightest harm; may scoop a hole in the little cot, and then depart quietly without giving any further cause for talk. Or this same lightning, terrible and ungovernable at times, will snatch something out of a person's hand with so much dexterity, one might almost say delicacy, that one would hardly dare to reproach him with his lack of ceremony.

At Perpignan on August 31, 1895, lightning fell on the mountains of Nyer, near Olette. Twenty-five out of a flock of sheep were struck. The shepherd was enveloped by a flash, yet escaped, but the knife he was

holding in his hand disappeared—and likewise his dog.

Another time it fell on a house at Beaumont (Puy-de-Dome), flashed through every part of it, blew up the stone staircase, and did considerable damage. It grazed a woman who was sitting with a cup in her hand, but she was not hurt, though the cup was rudely torn out of her hands.

In July, 1886, a labourer was in the act of mowing, when lightning coming on unawares, stole his scythe and threw it 10 metres away. The man was not in the least hurt.

The following example is truly amazing from this point of view.

A woman was busy milking a cow, when suddenly she saw a tongue of fire shoot into the stable and round it, pass between a cow and the wall at a place where there was not more than 30 or 35 centimetres of space, and finally go out of the door without leaving any marks, or hurting any living thing.

Very often lightning contents itself with making a frightful hubbub, and breaking any china or glass it may come across.

In July, 1886, thunder burst over a house at Langres. It was at breakfast-time. The fluid came down the chimney, which it swept thoroughly, came near the table, ran between the legs of an astounded

guest, and then knocked a hole as big as a shilling in the neck of a bottle which was being filled at the pump. Then it took itself off to the courtyard, which it swept clean, and disappeared without hurting any of the witnesses of this strange phenomenon.

On August 3, 1898, two women were in the dining-room of their house at Confolens, when lightning broke a pane of glass in the window, and passing within a few metres of them, went through the kitchen, and disappeared through the wall, after having broken several cooking utensils and the mantelpiece into atoms.

At Port-de-Bouc, on August 21, 1900, lightning struck the custom house, went into the room of one of the officials, and cut clean in two a china vase, which was on the mantelpiece, without separating the pieces.

Several days later, on August 26, the mysterious fluid came to disturb the peaceful repast of two honest labourers. Having taken refuge from the storm in a hut, they had set out their provisions for breakfast. All at once the thunderstorm burst into the humble dining-room, snatched up the bread, cheese, etc., overturned the bottles and other articles, covered everything with straw, as if by a violent gust of wind. The labourers felt nothing but stupefaction.

Was not it a veritable farce?

In another place it bursts open a cupboard, throwing the door away, and damaging the crockery in the

most systematic fashion: it breaks the first plate, leaves the second intact, cracks the next, spares the fourth, and so on to the bottom of the pile. Then its task finished, it becomes quite diminutive, like some little gnome out of a fairy story, and flees through the key-hole, but without making the key spring out of the lock.

On August 19, 1866, at Chaumont, lightning, having played havoc in a house in various ways, espied a pile of plates in a cupboard, china and earthenware plates being mixed, it broke all the china ones, leaving the others untouched.

Why this preference? The lightning does not explain. It is for us to find out.

On May 31, 1903, at Tillieu-sous-Aire (Eure), during a thunderstorm, a number of china plates were filled with a kind of sticky water. The earthenware plates beside them were not even wet. I received a little flask of this water sent me by the parish priest, but analysis revealed nothing unusual.

The following case gives a formal denial to the ancient prejudice which attributes a cabalistic influence to the number thirteen.

There were thirteen people in the dining-room of a house at Langonar while the thunder rumbled outside. Suddenly a flash of lightning struck a plate in the middle of the table, threw dishes, glasses, plates, knives,

and forks in all directions—in a word, cleared the table, not forgetting the tablecloth.

None of the thirteen guests were touched.

It sometimes happens, indeed, that glasses or bottles are altogether or partly melted. Boyle gives a very curious instance of the kind.

Two large drinking glasses were side by side on a table. They were exactly alike. Lightning seemed to pass between them, yet neither was broken; one was slightly distorted, however, and the other so much bent by an instantaneous softening that it could hardly stand.

When firearms are struck by lightning, their injuries are often of the most varied kind. Sometimes the wood, particularly of the butt-end, is split, or broken to pieces, the metal parts torn out, or thrown right away.

On July 27, 1721, the meteor struck a sentry-box at Fort Nicolai, Breslau, and pierced the top to get at the sentry and his gun. The barrel was blackened; the butt-end broken and thrown to a distance. The shot had been discharged and pierced the roof of the sentry-box.

The man got off with a few scratches.

However, firearms when carried by men appear to attract the lightning. Soldiers are often enough struck when in the exercise of their calling, when they are carrying arms.

But, curiously enough, many cases are known in which lightning has struck a loaded gun, melting the bullet and part of the barrel, without setting fire to the powder.

Thus, at Prefling, lightning penetrated the room of a gamekeeper, yet none of the many firearms hanging up went off. The wall was damaged between each rifle. One was standing in a corner of the room; the wall was injured on a level with the lower end, and above it a hole was to be seen in the woodwork.

On June 1, 1761, near Nimburg, lightning burst into the house of a horse-keeper, where it struck a loaded carbine leaning against a wall on the ground floor. The muzzle was slightly melted by the spark, which ran along the barrel to the trigger, and which it soldered together in parts. There were five bullets melted and soldered together in the magazine and the wads much scorched. However, incredible as it may seem, there was no explosion.

In another case the lightning went the whole length of a rifle, both inside and outside, leaving a direct line of fusion, and yet, incredible though it may seem, no shot was fired though the fusion reached the powder.

These phenomena appear quite extraordinary, and altogether incompatible with the usual theory of the combustibleness of gunpowder. To what cause can the invulnerability of the explosive matter be due?

Doubtless to the quickness of the lightning, which does not leave the powder time enough to ignite.

Powder magazines are frequently struck by lightning, and this subject is one of very great interest; they are not always blown up, in spite of the vast quantities of explosive materials which they contain.

Here are some examples which go to prove this statement:—

On November 5, 1755, lightning fell near Rouen on the Maromme powder magazine, and split one of the beams of the roof. Two barrels of powder were reduced to atoms without exploding. The magazine contained eight hundred of these barrels.

Can it be that man's thunder can repulse that of Jupiter?

Not always, as numerous examples prove the contrary. The following observations are extracted from a collection of similar facts:—

Lightning struck the tower of St. Nazaire, Brecia, on August 18, 1769. It stood above an underground magazine containing a million kilogrammes of powder belonging to the Republic of Venice. The whole edifice was blown up, the stones falling in showers. Part of the town was thrown down; three thousand people perishing.

At four o'clock in the afternoon of October 6, 1856, lightning penetrated the vaults of the church

of St. Jean, at Rhodes, setting fire to an enormous quantity of powder. Four or five thousand people lost their lives in the catastrophe.

The power of lightning is immeasurable. Well, it sometimes enjoys itself after the following manner:—

In 1899 it lit a candle which had just been put out. The person who held it was not struck, but the shock sent him to sleep for four days; then he awoke, only to go mad, and then slept for seven consecutive days.

At Harbourg it put out all the lights at a ball; the room was plunged in darkness, and filled with thick and fetid vapour.

Many a time, too, has a fire, burning brightly in a grate, been suddenly extinguished by lightning; and the same thing has happened with pottery and tile-making furnaces. As a rule, it is extremely difficult to re-light candles or fires thus extinguished. In some instances it takes on itself to light the gas.

On August 3, 1876, near the Observatory in Paris, Rue Leclerc, towards the corner of the Boulevard Saint Jacques, a gas jet was lit by lightning. The latter was twenty centimetres from a long gutter, and was in the gap, so to speak, of an electric circuit formed by it and the damp wall communicating with the ground. A violent explosion took place at the moment the gas caught alight, the gas meter, on the

wall two metres above it, was dislodged, when a second explosion was heard. The thunder-clap was truly terrific, and immediately followed the lightning flash. The chronometer in the meteorological bureau in the Observatory was stopped suddenly. The keeper of the square of the Luxembourg saw a ball of red fire explode with great violence, and scatter in all directions. The plate belonging to the Pères was, according to M. de Fonvielle, broken to a thousand pieces, and the outer part of an iron bar was volatilized. There were no deaths or injuries to record, although several people were thrown down by the shock.

Sometimes great disasters are indirectly caused by lightning. Thus in July, 1903, it set fire to an old house at Muda, Paluzzo. Under other circumstances, the accident might have been insignificant. But, fanned by a violent wind, the flames increased, and, approaching nearer and nearer, burned a hundred houses, or in other words, the whole village.

A similar catastrophe took place at the village of Ochres, in Dauphine, on August 27, 1900. Lightning set fire to twenty thatched cottages, which, out of thirty-two composing the village, were in ashes within less than an hour. Three persons were burnt alive, and four others seriously injured.

On August 25, 1881, lightning struck the village of Saint Innocent, at three o'clock in the morning.

Seven houses were totally burnt, and three women perished in the flames.

A fire caused by lightning burst out on June 24, 1872, at Perrigny, near Pontailler (Cote d'Or). Seventeen houses were burnt, and seventy-eight people found themselves homeless. Sometimes these disasters attain terrifying proportions.

During an awful thunderstorm, the electric spark set fire to eighteen parishes in Belgium; ruin spread over an area of 160 kilometres.

But could anything be more dreadful than the fate of certain ships that have been struck by lightning?

Here is the case of one which was literally cut in two.

On August 3, 1862, the ship *Moses*, on her passage from Ibraila to Queenstown, was overtaken in sight of Malta by a violent thunderstorm. Towards midnight lightning struck the mainmast, and then downwards along it to the hold, cutting the vessel in two. She filled immediately. Crew and passengers were lost. Captain Pearson was on the bridge, and had just time to catch a floating spar, which supported him during seventeen hours. The ship sank in three minutes.

At the commencement of last century, the ship *Royal Charlotte* being in Diamond Harbour, on the Hoogley, was struck by lightning and blown into a thousand

pieces, through the explosion of her powder magazine. The report was heard a great distance off, and the shock was felt for miles around.

The form and position of the masts exposes them particularly to the attacks of the dread meteor. Several examples are known of sailors being struck by the electric current while aloft in the rigging, and even being thrown from there into the sea.

On August 26, 1900, the steamer *Numidie*, sailing from Bone, was struck by lightning. The fluid fell on the mizzen-mast, and went down the standing jib, to which the second officer was clinging. The unfortunate man had had both his hands paralyzed and fallen; but if he had fallen on the outside of the draille, death would have been inevitable.

The *Rodney* was under weigh before Syracuse when it was struck. This was on December 7, 1838. The top-gallant-mast went first; it weighed eight hundred pounds, and such was the violence of the stroke that it was instantly reduced to shavings, which hung the whole length of the vessel, like rubbish in a carpenter's shop. The topmast was very much damaged and shattered here and there. As for the mainmast, with its ironwork weighing more than a ton, it was wrecked for a length of some seventeen metres.

At times the masts are split from top to bottom, broken or cut transversely in fragments, and flung to a

distance. Sometimes they are planed, like the beams and trees of which we have already spoken.

The *Blake* was struck by lightning in 1812. The top-gallant-mast was in green pine, which was split into long fibres in every direction, like branches of a tree.

It is not unusual for lightning to creep into the heart of a mast and do it all kinds of injuries, without in any way hurting the outside; in a word, there may be single or double furrows, longitudinal or zigzag, sometimes curved, and of varying depth. Sometimes also, the electric current, far more powerful than the blast of the wind, seizes the rigging and carries it off. This phenomenon was observed on the *Clenker*, December 31, 1828; the topmast and sails were torn off and thrown into the water. Neither are the sails spared by the terrible meteor; they are torn, riddled with holes, or set on fire. But as a rule the yards are spared.

One of the most frightful effects of thunder on ships is fire, which it drives from one part of the vessel to another. Under ordinary circumstances it is usually local, and easily extinguished; but when it seizes on various parts of the ship at once, as when struck by lightning, then destruction becomes inevitable.

In 1793 the *King George* from Bombay was sailing up the river at Canton, when an electric spark, followed by a violent clap of thunder, grazed the mizzen-mast,

and disappeared in the hold, after killing seven men. Seven hours later it was discovered with consternation that the hold, full of an inflammable cargo, was on fire. It spread rapidly over the whole ship, which it burned to the water's edge.

The ship *Bayfield* from Liverpool was struck by lightning November 25, 1845. Instantly the deck was seen covered with globes of fire and large sparks, which set fire to the vessel. As it threatened the powder-magazine, the captain decided to abandon the ship. A rush was made for the boats, but as only thirty pounds of bread could be saved, many perished of hunger and thirst.

Often, indeed, the explosion of the powder-magazine makes the catastrophe even more terrible. Thus, in 1798, the English vessel the *Resistance*, was blown up in the Straits of Malacca. Only two or three of the crew were saved.

But lightning plays more tricks with the compass than with anything else when it visits a ship. The vibrating, quivering, magnetic needle is often paralyzed by the electric current; sometimes its poles are reversed, or the points, disturbed by the passage of the spark, deviate, and no longer responding to the magnetic pole, mislead and move hither and thither.

Sometimes they even lose all their magnetic properties.

These changes in the compass often lead to disastrous consequences. Many cases are known of ships being steered to destruction through the deviation of the compass. Arago tells of a Genoese ship which, about the year 1808, sailing for Marseilles, was struck a little way off Algiers. The needles of the compasses all made half a revolution, although the instruments did not appear to be injured, and the vessel was wrecked on the coast when the pilot believed he could round the cape to the north. This may account for the total disappearance of certain ships.

Some ships, like certain individuals and certain trees, appear in particular to attract the electric fluid. We have many records of vessels struck several times in the course of a single electric storm. Here are a few :—

On August 1, 1750, the *Malacca* was struck repeatedly.

In 1848, the *Competitor* was struck twice within an hour.

At the beginning of December, 1770, between Mahon and Malta, the ship of a Russian admiral was struck three times in a single night.

On January 5, 1830, in the Straits of Corfu, the *Madagascar* received five destructive discharges in two hours.

We could add many others to this list. But

enough. And yet we have not said the last word on the subject. We have to discuss the interchange of sympathetic currents, and those which are the reverse, taking place between the electricity of the skies and that of the telegraph.

Lightning often comes incognito to visit the earth's surface, or even the depths of the ocean. These little excursions to our terrestrial dominions usually pass unperceived; however, in certain cases the telegraph wires commit the indiscretion of revealing them.

On the other hand, we know that the wires entrusted with carrying our thoughts round the world, are almost inconceivably sensitive. Without being conscious of the fact, they are in correspondence with the sun, 149 millions of kilometres away, and any agitation on the surface of this luminary may cause them indescribable agitation, as we witnessed at the close of the year 1903.

During the formidable magnetic tempest of the 31st October, telegraphic and telephonic communication were interrupted in many parts of the world. In fact, the phenomenon was observed all over the surface of the globe. From nine o'clock in the morning, till four in the afternoon, the old world and the new were strangers to one another. Not a word nor a thought crossed the ocean; the submarine cables were paralyzed on account of solar disturbances. In

France, communication between the principal towns and the frontiers was interrupted. During this time the sun was in a condition of violent agitation, and its surface vibrated with intense heat. In such times the subtle fluid profits by the confusion to glide noiselessly along the paths which are open to it. But he does not always wait for these favourable opportunities.

Let a thunder-cloud pass over the telegraph wires, either noiselessly or hurling petards in all directions, the line will be affected. The fluid imprisoned in the sky will act by induction on the electricity of the wires which will result in the vibration of the latter, accompanied sometimes by a flash of lightning. These phenomena may cause grave accidents to the telegraph clerks, unless they are on their guard against the treachery of the lightning. These mute discharges happen frequently, but the spark strikes the telegraph wires often, too, as well as the apparatus in the office. All sorts of accidents result from these repeated attacks.

We know, for instance, how the birds fall victims to the lightning when they alight on the telegraph wires after a thunderstorm; they are often found dead hanging by their claws.

But the fluid acts on man also, through the medium of the wires.

Thus, on April 13, 1863, a telegraph clerk was

engaged with several other employees repairing some telegraph wires in the station at Pontarlier, when all at once they felt, at the knee-joints more particularly, a violent shock which made them bend their legs as if they had been struck with a stick; one of them was even thrown down. No doubt the fluid reached the wires, which in those remote parts was in charge of the clerks.

On September 8, 1848, during a violent thunderstorm, two telegraph poles were thrown down at Zara in Dalmatia. Two hours later, as they were being set up again, a couple of artillerymen, having seized the wire, felt slight electric shocks, then suddenly found themselves flat on the ground. Both had their hands burnt; one indeed, gave no sign of life; the other, in trying to raise himself up, fell back as soon as his arm came in contact with that of one of his comrades, who ran to his assistance on hearing him cry for help. The latter thrown down in turn, felt his nerves tingle, and giddiness seize him, with singing in his ears. When his arm was uncovered, there was a superficial burn just on the spot where he had been touched.

On May 9, 1867, lightning fell on the road from Bastogne to Houffalize (Luxembourg), attracted by the telegraph wire, which it destroyed for about a kilometre. At a certain part, and over a length

of about twenty metres, the wire was cut in small pieces, three or four centimetres long, which were scattered over the ground, and were as black and as fragile as charcoal. The poles which supported them, and several poplars planted on the same side of the road, were more or less damaged.

It has been observed that trees planted on the same side as a telegraph line were sometimes blasted on a level with the wires. It is the same with houses near the copper threads along which human thoughts take wing. Thus, at Chateauneuf-Martignes, on August 25, 1900, lightning destroyed the telegraph poles on the outskirts of the railway-station. A severe shock, like an electrical discharge, was felt at the same moment by two people who were in bed, not far from where the wire was fixed in the wall of the house, which was a very low one. The same phenomenon had been felt there already.

In the railway-stations, as well as in the telegraph and telephone offices, curious results of the spark passing at a certain distance, or even in the immediate neighbourhood, are sometimes observed.

On May 17, 1852, towards five o'clock, the sky looking overcast, the station-master at Havre warned his colleague at Beuzeville that it would be well to put his apparatus in connection with the ground. Beuzeville is twenty-five kilometres away

from Havre, and at the former station the weather then did not look at all threatening. But clouds soon piled up, driven before a violent wind. Suddenly three awful peals of thunder succeeded each other in quick succession. With the last, lightning struck a farm about a kilometre from the station, and at the same moment a globe of fire of a reddish brown, and apparently about the size of a small bomb-shell, rose as if out of a clump of trees. It glided through the air like an aerolite, and leaving behind it a train of light. At a hundred metres or so from the station, it alighted like a bird on the telegraph wires, then disappeared with the rapidity of lightning, leaving no trace of its passage, either on the wires or the station. But at Beuzeville several interesting phenomena were observed. Firstly, the needles turned rapidly, with a grating noise like that of a turnspit suddenly running down, or like a grindstone sharpening iron, which emits sparks. A great number, indeed, flew out of the apparatus. One of the needles, that on the Rouen side, went out of order; all the screws on that part of the instrument were unscrewed, and on the copper dial near the axis of the needle, there was a hole through which one could pass a grain of corn.

The instruments at Havre were unaffected. The needle remained as usual, also the dial, screws, and so on.

One of our correspondents has sent me the following very interesting communication :—

"On June 26, 1901, having rung up at the central telephone-office at St. Pierre, Martinique, a harsh noise was heard, which was almost immediately succeeded by the appearance of a ball of fire, having an apparent diameter of twenty centimetres, and the brilliancy of an electric light of twenty candle power. This voluminous globe followed the telephone wire towards the instrument. Arrived near the receiver, it burst with a terrific explosion. The witness of this phenomenon felt a severe shock, and dizziness. Recovered from his stupefaction, he noted the following facts: the telephone apparatus was completely burnt, the relay of Morse's installation was slightly damaged. The electrical tension must have been enormous, for the wire of the bobbins was, to a great extent, melted."

This latter effect, however, occurs very frequently. Not only does the lightning melt and break the telegraph wires, but it injures the poles which support them.

These are sometimes broken, split, thrown down, burst, or splintered, sometimes into threads or shavings. Poles which have been blasted are often to be seen alternating with others which are uninjured. Thus, on the line from Philadelphia to New York, during

a great storm, every alternate pole up to eight was broken or thrown down; the odd numbers were uninjured. We have mentioned a similar case already.

There are several accounts, too, of lightning in pursuit of trains.

On June 1, 1903, travellers by train from Carhaix to Morlaix, between Sorignac and Le Cloistre, saw lightning follow the train over a course of six kilometres, breaking or splitting several telegraph poles.

This feat has been observed more than once. The train is escorted by lightning flashes which succeed each other almost without cessation, and the travellers seem to be whirled through an ocean of flame.

Lightning rarely strikes the carriages; only on one occasion did it actually wreck one, by breaking a wheel. The mutilated coach, however, continued to hobble along until the injury was discovered.

Generally the fluid is content to wander about the rails, to the great terror of the passengers who witness this display of rather alarming magic. It spreads itself over masses of iron, as for instance the roofs and balconies in Paris, without striking any particular point.

The danger would be greater to a cyclist on a road. In the suburbs of Brussels, on July 2, 1904, a cyclist named Jean Ollivier, aged twenty-one years, was riding during a violent storm, when suddenly he was struck and killed on the spot.

We shall end this description of the whims and caprices of lightning by a notice of the blasting of a German military balloon. It happened in June, 1902. The aeronaut, whose car was steered by a sub-lieutenant, was held captive, and soared at a height of about 500 metres above the fortifications at Lechfeld, near Ingolstadt. All at once the aerial skiff was touched by an electric spark, caught fire, and began to descend, slowly at first, then swiftly. The aeronaut had the good luck to get off with a broken thigh. The five assistants, who worked the windlass and the telephone, also received shocks transmitted through the metal wires of the cable. They fell unconscious, but were quickly restored. This phenomenon, which is excessively rare, fittingly closes this odd collection of stories, fantastically illustrated by lightning.

A communication from Berlin also mentions that the captive balloon of the battalion of aeronauts was struck by lightning on the exercise ground at Senne. Two under-officers and a private were wounded by the explosion.

CHAPTER IX

LIGHTNING CONDUCTORS

Until comparatively recent times, as we have seen, all that was known about thunderstorms was that they occurred pretty well all over the world, and generally in either spring or summer.

While efforts were being made on our old continent to establish by long and ingenious dissertations the exact degrees of relationship between lightning and the sparks given out by machines, in America practical experiments were being set about towards solving the problems of electricity.

Franklin it was who hit upon the idea of extracting electricity from the clouds for the purpose of investigation.

This man of immortal genius, who by his achievements in science, his noble character, and his devotion to his country, has won the admiration and gratitude of posterity, was of humble origin.

The son of a soap manufacturer in a small way of business, Benjamin Franklin was born at Boston in

1706. His parents had intended him to go in for science. He was successively an apprentice to a candle manufacturer, a journeyman printer, the head of a big printing firm in Philadelphia, deputy to Congress, an ambassador, and finally President of the Assembly of the States of Pennsylvania. His political record was a great one. No one ever rendered greater services to his country than the diplomatist who signed the peace of 1783, and insured the independence of the United States.

It was towards the age of forty that Franklin began his study of electricity. Here is his own account of the memorable experiments to which he owed the greater part of his immense fame :—

"In 1746 I met at Boston a certain Dr. Spence, who came from Scotland. He performed some electrical experiments before me. They were not very perfect, as he was not a man of great ability; but as the subject was new to me they surprised me and interested me in an equal degree. Shortly after my return to Philadelphia, our librarian received as a gift from Pierre Collinson, a member of the Royal Society of London, a tube of glass, together with certain written instructions as to the way in which it should be used for experiments. I seized eagerly on the chance of reproducing what I had seen done at Boston, and with practice I acquired a great facility in performing the

experiments indicated to us from England and in devising other ones. I say 'with practice,' because many people came to my house to witness these marvels."

After making several discoveries in regard to electricity, Franklin took it into his head to extract the fluid direct from the clouds. He had established the fact that a stem of pointed metal, placed at a great height—on the summit of a building, for instance—served as an attraction to lightning and guided it into the way prepared for it. He had been looking eagerly to the erection of a clock-tower which was being built at this time at Philadelphia; but, tired of waiting and anxious to carry out experiments which should solve all doubts, he had recourse to a more expeditious instrument, and one, as events proved, not less efficacious, for getting into touch with the region of thunder—a kite such as children play with.

He prepared two sticks in the form of a cross, with a silk handkerchief stretched upon them, and with a string attached of suitable length, and set forth on his mission the first time there was a storm. He was accompanied only by his son. Fearing the ridicule that is showered upon failure, he did not take any one else into his confidence. The kite was set flying. A cloud which looked promising passed without result. Others followed, and the excitement with which they were awaited can be imagined.

At first there was no spark and no sign of electricity. Presently some filaments of the string began to move, as though they had been pushed out, and a slight rustling could be heard. Franklin now touched the end of the string with his finger, and instantly a spark was given out, followed quickly by others. Thus for the first time the genius of man may be said to have come to grips with lightning, and begun to learn the secret of its existence.

This experiment took place in June, 1752, and made an immense sensation throughout the world, and was repeated in other countries, always with the same success.

A French magistrate, named de Romas, making use of Franklin's idea as soon as it was known in France, took it into his head to use a kite with raised cross-bars, and in June, 1753, before the full results of Franklin's experiments were made public, secured still more remarkable signs of electricity, having inserted a thread of metal throughout the whole length of the string, which was 260 metres. Later, in 1757, de Romas repeating his experiments during a storm, secured sparks of a surprising size. "Imagine before you," he said, "lances of fire nine or ten feet in length and an inch thick, and making as much noise as pistol shots. In less than an hour I had certainly thirty lances of this length, without reckoning a thousand shorter ones of

seven feet and under." Numbers of people, ladies among them, were present at these experiments. They were not without danger, as may be imagined; de Romas was once knocked over by an unusually heavy discharge, but without being seriously hurt.

Franklin was the first to turn his experiments to practical account, attaching lightning-conductors to public and private buildings for their protection, and achieving marvellous results; the lightning being caught by the metallic stem and following it obediently into the ground.

From this time, lightning-conductors came into almost universal use, and their value was not long in being generally recognized. Curiously enough, France, which had been ahead of all other countries in the study of electricity, was not one of the earliest to go in for lightning-conductors. There were, indeed, signs of strong hostility to their introduction. It was held even that they went against the designs of Providence. In 1766, the Abbé Poncelet, in his work entitled "La Nature dans la formation du tonnerre et la reproduction des êtres vivants," in which he sets out to demonstrate that the force which produces lightning is the same as that which causes the earth to fructify, makes a strong protest against the construction of lightning-conductors.

In 1782, nevertheless, at the reiterated request of

Le Roi, a member of the Academie des Sciences, and friend and admirer of Franklin, the Louvre was endowed with the first lightning-conductor put up on a public building in France. Soon afterwards they became common.

In 1784 the Academie des Sciences drew up the first set of rules for the construction of lightning-conductors. It was revised and corrected in 1823, in accordance with the various improvements that had been introduced up till then, and it has been further added to in 1854, 1867, and 1903. These instructions point out that the most important metallic portions of the building should be placed in communication with the conductor, and this should sink into a well. Conductors that are not perfectly constructed are a source of danger, instead of being a protection, for the electric current is apt, instead of running down into the earth, to make for any kind of metallic substance, and cause great havoc.

The conductor ought really to communicate with a large body of water—a body of water of greater extent than the storm cloud from which the lightning comes. When the flow is insufficient, the water itself is apt to become electrically charged. It is dangerous to bury the conductor in merely damp soil; first, because one generally does not know whether there is enough of this soil; secondly, because one cannot be sure that the humidity will be sufficient at times of great drought

—the very times when storms are most to be feared. Failing a river or great pond, the conductor should be put into wells issuing or having their source in inexhaustible supplies of water deep down in the soil.

In his table of statistics showing the number of cases in which lightning has struck either lightning-conductors, or buildings, or ships furnished with conductors, Quebelet gives a hundred and sixty-eight cases in which the conductor has been struck, and in only twenty-seven instances of these (one-sixth of the whole) have the conductors, from some grave flaw in their construction, failed to fulfil their office. These results are the best proof possible of the efficacy of conductors, and the best answer to those who decry them.

The area of protection covered by the conductor is not so great as is generally supposed. It is limited to a distance about three or four times the length of the conductor above the roof. Thus a conductor standing out five yards will protect an area stretching only about fifteen or twenty yards away. This depends also to some extent upon the nature of the place and the materials of which the house is constructed.

Buildings are often struck by lightning because the number of conductors has been insufficient for the extent of the edifice to be protected.

To remedy this defect, conductors are made with a number of separate stems—veritable wire traps in which to catch the lightning. This system, the invention of a Belgian physicist, M. Melsens, decreases considerably the risks of destruction, and is much more economical than the erection of a number of separate conductors.

A conductor of this kind has been installed on the Hotel de Ville at Brussels, which has been well protected from lightning ever since, whereas previously this building had been struck by lightning several times in spite of the single conductors with which it was supplied. The metallic trellis is in communication with the sewers.

The slaughter-houses of La Villette, the Hôtel Evigné, and other buildings in Paris, are provided with similar defences.

The Eiffel Tower boasts several such multiplex conductors. It has often been struck by lightning, but no one who has happened to be up it at the time has ever suffered any damage therefrom. The lightning strikes the conductor sometimes from out the actual cloud—curious photographs have been taken of this. The Eiffel Tower is in itself a gigantic lightning-conductor.

Portable conductors have been invented from time to time—silk umbrellas without iron ribs, and clothes

of indiarubber and such-like; but they have all been childish things.

Without allowing one's self to get lightning, so to speak, on the brain, it is well to take certain precautions during a storm.

The first and principal one is not to get under a tree.

The second is to give a wide berth to telegraph posts, so as to avoid contact with the sparks that may issue from them.

Movements of the air having the effect of preparing an excellent route for the fluid, it is well not to run in a storm. It is well also not to ring a bell.

It is well, also, to avoid being in the neighbourhood of animals, in view of their attraction for lightning.

In houses, doors and windows should be closed in order to avoid draughts. It is well to keep away from the chimney, too, as well as from metallic objects.

But lightning always has its caprices. It is this that makes its study so interesting.

CHAPTER X

PICTURES MADE BY LIGHTNING

In this last chapter I would like to group together a series of instances of pictures made by lightning, some of them very curious and attributed, it would seem, to flashes of a special character, which we may perhaps term Ceraunic Rays, from *Keraunos*, lightning. These instances are of great variety, and doubtless admit of many different explanations. Here, then, is a selection worth looking into.

In this case, as in so many others, it is extremely difficult to get at the exact truth.

Generally speaking, it is from the newspapers that we get the facts—more or less accurately observed, more or less accurately recorded. I have made great efforts to inform myself personally as to the incidents whenever this has been practicable.

The *Petit Marseillais* of June 18, 1896, published the following:—

"A correspondent writes to us from Pertius, June 17:—

"'In the course of the storm here yesterday, two

day-labourers of our town, Jean Sasier and Joseph Elisson, took refuge in a cabin constructed of reeds. They were standing at the entrance when they were struck by lightning and thrown violently to the ground. Elisson, who was not much hurt, soon recovered his senses and called for help. People ran up at once and carried the two men to where they live, where all necessary attention was given to them.

"'Sasier's condition, though serious enough by reason of a burn on his right side, is not causing anxiety. The curious part of the incident is the effect the electric fluid has produced upon Elisson. The lightning cut open one of his boots and tore his trousers; but over and above this, like a tattooer making use of photography, *it reproduced admirably* on the artisan's body a representation of a pine tree, of a poplar, and of the handle of his watch. It is an undoubted case of photography through opaque materials; most luckily the sensitive plate—Elisson's body—merely took the impression and received no injury.'"

On reading this narrative, I wrote to the Mayor of the Commune of Pertius to ask him for confirmation of it, and for a photograph, if possible, of the picture on Elisson's body. By a fortunate circumstance, the Mayor happened to be the doctor who had attended the victim. Here is his reply:—

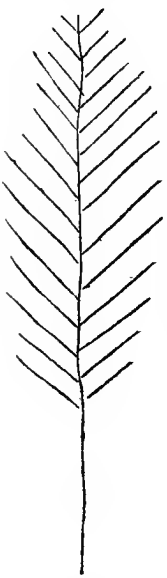
"M. Joseph Elisson, of Pertius, aged about

thirty-eight, was struck by lightning on June 17. Called to attend to him at about two in the afternoon, I found some superficial burns forming a trail, which began near the teat of his left breast, at the level of his waistcoat pocket, in which there was a watch (which had not stopped), and went down towards the navel, then turned boldly to the right towards the iliac spine and down the outer side of his right leg as far as the ankle, at the level of which his boot, made of strong leather, had been split open.

"To the right, a little outside the vertical line passing the teat, there was imprinted in vivid red—the red of the burn—a picture of a tree. The foot of it was on a level with the edge of the ribs, the top went slightly above the teat. This picture was absolutely vertical. Its outlines stood out very distinctly from the white skin. It was composed of bold, clearly defined lines, about a demimillimetre in width. Neither waistcoat nor shirt were burnt or marked in any way to correspond with it. Other representations of tree branches were reproduced higher up on the breast, but not so distinctly in the midst of a uniform redness. Not having by me my camera, I made a sketch of the tree, which was marvellously distinct, leaving the taking of a photograph until next day. Next day, when I returned with my camera, the picture was still clearly visible, but it had faded a good deal,

lost in the colour of the skin, and no longer to be reproduced by photography. I regretted bitterly not having taken it the day before. I regret this all the more now that you have done me the honour of writing to me on the subject, and I am glad to be able to send you my sketch of the picture, which is correct as to dimensions, and which represents what I saw as accurately as I could make it.

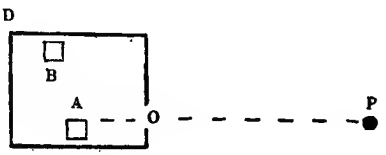
"Dr. G. Tournatoire."



Here is a facsimile of the sketch enclosed by the doctor.

It is somewhat like the shape of a poplar. There is nothing to suggest that we have here a case of swollen veins, or arteries made conspicuous by a flow of blood, nor of a tree-like form due to blood vessels, in which the blood has taken on a more or less marked aspect. On the other hand, it is certainly not much easier to recognize in it a photograph of a more or less distant tree. In this state of uncertainty on the subject, I wrote again to Dr. Tournatoire, and begged of him to go to the scene of the incident and to make a plan of the ground, and take a photograph of the view. Here is the doctor's reply :—

"This plan can be reproduced by a few typographical lines in such a way as to show clearly how things happened—



"The square represents the cabin in which the two workmen took refuge. They were sitting almost opposite each other on the seats marked A and B. There is a flash of lightning. One of the men is knocked over, and bears on his right side a picture of the poplar P, which stands one hundred metres away, and is visible by A through the door O, of which the width is one metre. Behind this poplar stands a big pine, a branch of which is also depicted on the man's body. By this same stroke of lightning the other worker, seated at B, is thrown out of the cabin three metres by an opening D, about forty centimetres wide. The two men are alive, and have come out of it with a few days' rest. They saw nothing, heard nothing, and can remember nothing."

In the photographs taken by Dr. Tournatoire it is not clear which is the tree, for the poplar, P, does not stand out alone. As the cabin stands under the shade

of a pine tree, one is disposed to ask whether the lightning did not strike this pine? But judging by the position of the trees relatively to the man struck, the most likely hypothesis is that the electric discharge came from the point P towards A, and that the poplar as well as the adjacent pine formed a sort of screen, and reproduced their reflection by the agency of some unknown constituent of these Ceraunic Rays, which enable them to photograph things in this way through clothes on to the human body.

This assuredly is a more extraordinary effect than those obtained by the cathodic rays or anti-cathodic rays, of which science seems equally unable to give any explanation.

Let us proceed with our studies. It is important above all never to take the newspaper narratives on trust without verification. In the month of June, 1897, the following appeared in the newspapers:—

"PHOTOGRAPHIC LIGHTNING.—A *chasseur* of the 15th battalion, in barracks at Remiremont, was struck by lightning. He was standing upon a mound not far from a grove of pines, in the midst of ferns. Curious to relate, on the occasion of recording the fact of the man's being dead, it was discovered that his body was covered with punctures imprinted on it by the lightning, and representing the nature and aspect of

the branches and plants all round him at the time when he was struck."

I wrote at once to the *chef de bataillon* for a precise confirmation of this, and received the following reply:—

"M. le Commandant Joppé, commanding officer of the 15th Battalion of Chasseurs, has handed me your letter of June 14th, and asked me to reply to it.

"It is the case that a *chasseur* of the battalion was struck by lightning on the afternoon of June 4, but it is quite untrue that there was found on his body a photograph of the trees adjoining the spot of the accident. The man's clothes were not affected in any way, and the only traces left by the passage of the lightning, consisted in some slight irregularly shaped burns on the upper part of the hollow of the right temple of linear formation, save for one circular burn measuring from three to four millimetres in diameter, and depressing the skin into the shape of a saucer. There was no lesion on the whole surface of the body.

"MAUNY,

"Surgeon-Major 15th Battalion of Chasseurs."

This reply was covered by a note which ran as follows:—

"I thought it desirable that the reply to your letter of the 14th inst. should be made by the surgeon-

major of my battalion in order that it might be the more scientifically accurate and authoritative.

"JOPPÉ,
"Chef de bataillon breveté,
"Commanding Officer of the 15th Battalion of the Chasseurs des Vosges."

Clearly, the student of natural phenomena cannot take too many precautions. And yet . . . an officer of high rank confided to me recently that "surgeon-majors hardly ever take the trouble to examine bodies thoroughly," and that it is possible that in this case "the examination may have been very superficial." If this be a general rule, there must have been an exception here, as also in the fifth case, to which we shall be coming just now.

The problem is far from being solved, and we can but seek to study it as set forth in a number of instances. Here is a third case:—

On Sunday, August 23, 1903, a certain number of riflemen were practising at the Charbonnières range, near the village of Le Pont, in the valley of Lalle Joux (Canton de Vaud, Suisse), five targets out of six were in use. The targets, distant 300 metres from the firing-line, are placed to the side of a grove of pines. Between stretches an undulating rock-strewn meadow-land. Only the butts are provided with a lightning-conductor,

and in it are five markers. *There are six telephone wires along the line of fire;* they come as far as the stand and go down to within about 50 centimetres of the scorers' seats. *Each target has its own telephone bell.*

The weather was not stormy, though the sky was somewhat overcast. Firing was going on. At about 3.30 there was a clap of thunder, and lightning struck the electric wires. In the stand twenty-eight men, riflemen, scorers, and spectators, are thrown to the ground in every direction and in every position. Some are quite inert, apparently dead; others, looking as though they were asphyxiated, give out a painful rattling noise from their throats. At the bar, to the side of the stand, no one felt anything—it was not even noticed that there had been a violent stroke of lightning. A kilometre away the band, which had been giving a concert in front of the Hotel de la Triute on the bridge, continued to play. Presently a man reaches them with the report that twenty of the riflemen have been killed. Consternation becomes general, and relief parties are organized. Fortunately the damage done was much less than was supposed.

Let us describe the men actually engaged in firing, and placed in a line, A, B, C, D, and E, their scorers are behind them.

Let us give our attention, first, to these men and their scorers. Presently we shall come to the others

awaiting their turn, then to the spectators, and finally to the markers at the targets.

The men were firing, either kneeling or lying.

A remained in position, kneeling "like a statue," unable to move. He turned right over as soon as he was touched. Killed.

B had *a pine tree depicted on his breast*—upside down, its roots indicated by some outlines up at the top; the picture was of a brownish rather than a blueish shade. It was suggested that it resembled a pine, because of a pine being ten metres away from the stand, but really it was more like a branch of fern. Killed.

C felt hardly anything apart from a certain heaviness in his limbs when picking himself up.

D had some slight burns, which were healed within two or three days.

E was holding his rifle with the barrel vertically. He found himself about 2½ metres from his position on the ground, with a stone in his hands; his rifle had been bent in two below the trigger.

A's scorer held the pear-shaped handle of the electric bell between his fingers, his elbows upon the table. Saw nothing, heard nothing. Felt himself suddenly bent up double, his face buried in the gravel; lost consciousness while he was being carried away; when he came to himself again he began to

ramble in his speech; his pencil was broken lengthwise into four pieces. The wire of his bell had been electrified. By way of wound, he had a picture of a pine branch on his back; water issued from it as from a blister; there were no traces of blood. The picture disappeared at the end of two days. For a certain time the young man had a pain in his loins; he still limps somewhat; probably what he now suffers from is sciatic lumbago, the result of partial and temporary paralysis.

B's scorer had only some insignificant burns.

C's scorer only came to himself twenty minutes later as the result of artificial respiration. At the moment of the lightning he was pressing the electric button with his thumb in order to give the signal, "Change the target;" he had a small hole in his thumb. This burn bled later, and the wound took four weeks to heal. He had also some burns on his legs.

D's scorer was holding the handle of the bell against his left cheek, on a level with his eye. The handle, made of wood, burst. The sight of his left eye is still affected, being very weak—the retina was probably torn away. The day after the accident, the young man's face became all inflamed, especially the part round the eyes. These were quite hidden. This inflammation, of a bluish tint, is due to the dilation of the small veins or of the capillaries.

Dr. Yersin, who attended several of the victims, attributes this dilation to a paralysis of the vasomotor nerves, "*which would also explain the tree-like form of the pictures seen upon the skin,*" and the transudation (?) of water across the small blood-vessels.

E's scorer had time to see the men on his left fall, in a green or violet light. He had heard a general death-rattle-like chorus, "Aôôô"—then, before he could make out what was happening, he found himself driven up against the wall of the stand. He had a wound under his feet; his thumb torn also, probably in trying to hold himself up against the wall.

Behind the scorers were a dozen other riflemen and some spectators. To the left the electric current left intact the rifles standing on the rack. Quite near this, a man awaiting his turn fell, clinging on to the neck of one of his comrades, also struck. Later he found his purse in the middle of the stand.

In the case of several of the spectators, the burns were to be found in separate sores. One had his hair burnt on one spot of about the size of a five franc piece; others, who had burns upon their feet and legs, are under the impression they saw a small blue flame at the tips of their shoes.

The general feeling was at first merely that of stupefaction. Terror did not come until afterwards. "Those who did not lose all consciousness were half

stunned." A young boy was noticed jammed up against the wall, incapable of moving, but bewailing his inability to get to his father, who lay dead upon the ground. Two men took flight without throwing aside their guns; another ran as far as the village, and some hours afterwards he was found asleep in a house "to which there was nothing to take him." One young spectator, a stranger to the neighbourhood, was seized with a partial paralysis of the brain; he could not keep his balance when walking, and when questioned he would recite the names of stations on a Swiss railway. He is better now.

This event will not be soon forgotten in the Joux valley. But Dr. Yersin's explanation of the Ceraunic pictures does not seem to me to be justified.

Here is a fourth instance, given me long ago by one of the most learned physicists of last century, Hoin, of the Institute.

"I am going to tell you," he wrote to me in July, 1866, "of a stroke of lightning which was very curious in its effects. It occurred at midday on June 27, at Bergheim, a village situated to the north of Logelbach at the foot of the Vosges. It struck two travellers who had taken refuge under the tree and knocked them over senseless—one of them was lifted to a height of more than a yard and thrown upon his back. It was thought they must be dead, but thanks to the attention given

to them at once, they were brought to themselves, and they are now out of danger. But here is the strange feature of the accident. Both travellers have on their backs, extending down to their thighs, *the imprint, as though by photography, of the leaves of a lime tree;* according to the statement of the Mayor, M. Radat, *the most skilful draughtsman could not have done it better.*"

Here is a fifth instance which I find among my records. The incident happened at Chambéry, May 29, 1868.

In the course of a violent storm, a soldier of the 47th Regiment was struck by lightning underneath a chestnut tree. In a memorandum drawn up on June 18 by a learned doctor of Chambéry, an eyewitness of the occurrence, the following facts are recorded:—

"The man who was killed had been standing in the centre of a group of eight soldiers, who had their guns in their hands, without bayonets. Struck in the region of the heart, he did not succumb for about a quarter of an hour, after saying a few words. The corpse bore an oval plate, so to speak, of about 13 to 14 centimetres in length, by 4 to 5 in width, occupying largely the precordial region, and presenting the parchment-like aspect of a vesicatory that had become rapidly dried up. The clothes were neither torn nor burnt.

"Two hours after his death an examination of the

body resulted in the discovery of a phenomenon already recorded by several observers—the reproduction of photo-electric pictures.

"On the right shoulder were three bunches of leaves of a more or less deep reddish violet hue, reproduced minutely with the most absolute photographic precision. The first, situated on the lower part of the inside of the forearm, represented a long branch of leaves like those of a chestnut tree; the second, which seemed to be formed by two or three such branches twisted together, was in the middle of the outside of the arm; and the third, in the middle of the shoulder, larger and rounder, showed only some leaves and small branches at the top and at the borders, the centre presenting a red stain diminishing towards the circumference. The body, when dissected, bore no sign of any interior lesion."

Here is a sixth instance:—

In June, 1869, a Trappist was struck by lightning at the monastery of Scourmant, near Chimay in Belgium. It was the afternoon, and the monks were busy mowing. The storm coming along obliged them to seek shelter. One of them, who was following the mowing machine worked by two horses, directed it towards an iron-work enclosure, and knelt down beside this trellis. There was a terrible thunder-clap, the horses bolted in their fright, and the monk remained with his face to the

ground. The others, who saw him fall, ran up to his assistance, only to find him dead. The medical attendant of the monastery, sent for at once, discovered on the body two large and deep burns, identical in shape, and placed symmetrically to each side of the breast; he pointed out also to those who were present a white spot under the left armpit, *presenting a very distinct picture of the trunk of a tree with branches on it.*

Out of these six cases, five may be taken as fully authenticated.

Dr. Lebigne, Mayor of Nibelle (Loiret), published the following narrative in the *Moniteur* of September 7, 1864.

"On Sunday, September 4, 1864, at about 10.30 a.m., three men were busy gathering pears about 200 metres out of Nibelle, when the pear tree was struck by lightning, and was distorted from top to bottom in the form of a screw; the lightning carried away the bark and about a centimetre of the wood beneath; then quitting the tree, it struck the head of one of the workmen, who was eating some bread at the time, and killed him, as well as a dog by his side. The head was burnt behind from top to bottom and was impregnated with a strong smell of sulphur.

"The two other workmen who were on the tree were thrown to the ground, and remained for some time

senseless. When they came to themselves they could not move their legs. They were taken to their homes, and it was found that both had been in contact with the electric fluid. The astonishing thing about them is, that *one of them had the branches and leaves of the pear tree clearly imprinted on his breast as though by daguerreotype.* The terrible photographer had been merciful, however, for that evening both the men were up again and able to walk."

The *Comptes rendus* of the Academie des Sciences for the year 1843 (xvi. p. 1328) records that in July, 1841, in the department of Indre-et-Loire, a magistrate and a miller's boy were struck by lightning in the vicinity of a poplar. It was found that both of them had on their breasts stains exactly like the leaves of a poplar. These marks, in the case of the magistrate, went away gradually as the blood began to circulate again. In the case of the boy, who was killed on the spot, they had faded somewhat by the day after, when decomposition had begun to set in.

A propos of this case, very similar to those preceding, Arago recalled the fact that in 1786 Leroy, a member of the Academie des Sciences, declared that Franklin had several times told him how a man who was standing at a door during a storm had seen a tree struck by lightning opposite him, and that a representation of this tree was found imprinted upon his breast. Arago

recalled, too, in this connection a report made to the old Academy in August 2, 1786, by Bossuet and Leroy, in which there was question of a man killed by lightning on May 10, 1585, in the Collegiate School of Riom in Auvergne; in this case the electric fluid had entered by the heel and gone out by the head, leaving on the body singular marks, described in the report. It was thought that the lightning on its way, through having forced the blood into all the vessels in the skin, must have made all the ramifications of these vessels sensitive to impressions from without. Extraordinary though this may appear, they go on to say, it is not new; Père Beccaria cites a similar case; and Franklin's case is cited here also as analogous. Besile, the author of the record of the Riom case, "did not hesitate," he tells us, "to attribute the effect to an eruption of the blood in the vessels of the skin, producing a result similar to that of an injection." The statement in the *Comptes rendus* is entitled "Strange appearance of Ecchymoses formed by lightning upon the skin of two persons."

That is just the question. Was there in these pictures nothing but ecchymoses—infiltrations of the blood into the cellular tissue? Perhaps that may be so in some cases, but not in all. Photography, the photo-electric pictures produced in the laboratories of physicists, Moses's *figures* (?), the Lichtenberg flowers, cathodic rays, Rontgen rays, radiography—all these

things open new horizons for us. And even if we do not find any explanation satisfactory, we should not be justified in accepting the first offered to us as being so, if in fact it be not.

Here are four interesting cases recorded by Poey in his "Rélation Historique des images photo-electriques de la foudre."

Mme. Morosa, of Lugano, seated near a window during a storm, experienced a shock from which she is not stated to have suffered any ill effects; but a flower, which had stood in the route of the electric current, was found perfectly *drawn* on her leg, and this picture lasted the rest of her days.

In August, 1853, a young girl in the United States of America was standing at a window facing a nut tree at the moment of a dazzling flash of lightning; a complete picture of the tree was reproduced on her body.

In September, 1857, a peasant woman of Seine-et-Marne, who was minding a cow, was struck by lightning under a tree. The cow was killed, and the woman was thrown on the ground insensible. She was, however, soon revived. In loosening her clothes to attend to her, the people who came to her assistance found perfectly reproduced on her breast *a picture of the cow.*

On August 16, 1860, a mill at Lappion (Aisne), belonging to M. Carlier, was struck by lightning. On

the back of a woman of forty-four, who was also struck, the lightning left a reproduction (of a reddish hue) of a tree—*trunk, branches, foliage, and all.* Her clothes bore no trace of the passage of the lightning.

Unless we are to suppose that all these have been inaccurately observed, it seems to me that we must admit that there is something else besides ecchymoses, something else besides the workings of veins and arteries in these pictures wrought by lightning.

Certain of these tree-like pictures resemble the patterns we get in photographing electrical discharges upon sensitized plates. Might they not be produced by this discharge upon the surface of the body—or by the emission of electricity from the body struck?

The pictures we shall now hear of, to be distinguished from those already dealt with, are easier to explain, and about their genuineness there can be no doubt.

In the summer of 1865, a doctor from the neighbourhood of Vienna, Dr. Derendinger, was returning home by train. On getting out at the station he found that he had not got his purse on him—some one probably had stolen it.

This purse was made of tortoise-shell, and had on one side of it a steel plate marked with the doctor's monogram—two D's intermingled.

Some time after, the doctor was called to attend to

a stranger who had been found lying insensible under a tree, having been struck by lightning. The first thing that he noticed on examining the man's body was that on his thigh there was a reproduction, as though by photography, of his own monogram. His astonishment may be imagined. He succeeded in reviving the stranger, who was taken to a hospital. The doctor remarked that in his clothes his lost tortoise-shell purse would probably be found. So it proved. The individual struck by lightning was the thief. The electric fluid had been attracted by the steel plate, and had imprinted the monogram upon the man's body.

In this case we are set thinking of electro-metallurgy, all the more because there are a number of other instances which certainly belong to this category. Thus, for instance, on July 25, 1868, at Nantes, a stranger near the Pont de l'Erdre, on the Quai Flesselles, was enveloped by a flash of lightning, but proceeded on his way without experiencing any ill effects. He had on him a purse containing two pieces of silver in one compartment and a ten-franc piece in gold in another. On taking out his purse he found that a coating of silver taken from one of the silver pieces—a franc—had been transferred to both sides of the ten-franc piece. The franc, slightly thinner, especially over the moustache of Napoleon III., was in parts

slightly bluish. This transference of the silver on to gold was made through the skin of the partition of the compartments ! *

Another case. In Gilbert's "Annalen der Physik" (1817) we read that a flash of lightning struck the tower of a chapel near Dresden and took the gilt off the framework of the clock and transferred it to the leaden runs of the window-panes in such a way as to leave no sign of how these had been gilded.

In these cases the analogy with galvano electro-metallurgy is evident. But in the earlier cases this was not so; the trees contained no metallic element. It was not a case of transference. They seem to have been photographed by the ceraunic rays.

On October 9, 1836, a young man was killed by lightning. The corpse bore in the middle of the right shoulder six rings of flesh-colour, which seemed the more distinct in that the rest of the man's own skin was very dark. These rings, overlapping each other, were of different sizes, corresponding exactly with those of the gold coins which he had on him on the right side of his belt, as the public official who examined his body and all the witnesses were able to testify.

This makes us think of radiography.

A correspondent of Poey, the astronomer, told him that he had known a Trinidad lady who had been

* Académie des Sciences, Août 3, 1868.

struck by lightning in her youth and on whose stomach the lightning had imprinted a metallic comb which she carried in her apron.

In these instances there was some kind of contact of the objects with the persons struck. Here are others in which the objects reproduced are further removed, but still of metallic substance and still reminding us therefore of electro-metallurgy.

In September, 1825, the brigantine *Le Buon-Servo*, at anchor in the Bay of Armiro, was struck by lightning. A sailor seated at the foot of the mizzen-mast was killed. On his back was found a light yellow and black mark, beginning at his neck and going down to his loins, where there was discovered an exact reproduction, in facsimile, of a horseshoe nailed to the mast.

The mizzen-mast of another brigantine was struck by lightning in the roadstead of Zaube. Under the left breast of a sailor who was killed was found imprinted the number 44, which his mates all declared was not there before. These two figures, large and well formed, with a full stop between them, were identical with the same numbers in metal affixed to the rigging of the ship, and placed between the mast and the sailor's bunk, in which he was lying asleep when struck.

May it not have been a tattoo-mark in spite of what his companions declared ?

M. José Maria Dau, of Havana, records that in 1838, in the province of Candaleria, in Cuba, there was found on the right ear and on the right side of the neck of a young man struck by lightning, the reproduction of a horseshoe, which had been nailed up at a short distance from him against a window.

These various records lead us to the reflection: first, that ceraunography should form a new branch of physics, well meriting study; secondly, that the facts set forth are sufficiently inverse in their nature to show us that we have before us several quite distinct specimens of phenomena.

However, these matters have been a subject for study long before our day.

A priest, P. Lamy, of the Congregation of Saint Maur, published in 1696 an excellent little work,* informed by the most lucid common sense upon the curious effects of lightning—then a text for the most superstitious commentaries. Voltaire could not have reasoned the thing out better. He deals with two very extraordinary cases among others.

The first had for scene the Abbey of Saint Médard, at Soissons, on April 26, 1676. A flash of lightning struck the tower of the abbey, went into the clock, penetrated a wall eight feet thick, by a hole conducting

* "Conjectures physiques sur les plus extraordinaires effets du Tonnerre." Paris, MDCXCVI.

an iron rod *à l'aiguille de cadran*, detached two planks, four feet high, and threw them to the extreme end of the dormitory, followed a brass wire stretched along the whole length of the wall, setting fire to it and spreading it out like a ribbon painted to represent a furrow of flames. Here is the author's own description :—

"The most surprising effect, and one which has aroused the curiosity of an immense number of people, is a kind of frieze of all kinds of colours extending along the wall of the dormitory and just above the doors.

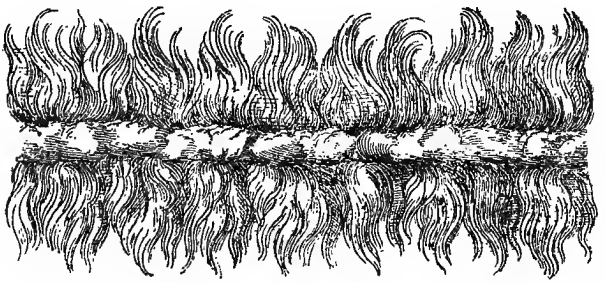
"The depth of this frieze is about two feet; its length is almost equal to that of the dormitory; the designs upon it are of flames darting up and down from a kind of wide band which occupies the centre of the frieze throughout its length.

"I have had a portion of this frieze copied, so as to give the reader an idea of it, but it must be admitted that it is difficult to suggest the variety of *nuances* in the original. Some people declare that in the midst of all the colours in the flames, faces of men may be descried as well as of marmosets and demons; but those who are less richly endowed with imagination can see nothing of all this."

On p. 274 is a copy of the design by P. Lamy.

At this period, physicists were of the belief that lightning was "an exhalation of nitre and sulphur,

acting something after the fashion of powder, and able to burn up or throw over everything encountered on its route. In this girdle traced by the lightning, the



author sees a scattering of all the constituents of the brass wire, transformed into all kinds of colours due to the dilation of the copper, melted and vaporized over the width of two feet, the colours, in which yellow predominates, varying according to the thickness and the inequalities of the "projection."

The second case examined into by P. Lamy, was that of what happened in the church of Sauveur at Lagny, when it was struck by lightning on July 18, 1689. This is one of the most astounding in the entire history of the subject. Let us see what our author has to tell us:—

"If we were to look for some excuse for the strangeness and diversity of the people's sayings and doings in connection with the Lagny case of lightning, we should

assuredly find it in the extraordinary nature of the case itself.

"For what would naturally be the effect upon minds accustomed to see mysteries in the most transparently natural events, minds whose philosophy never goes beyond the senses, when they learn—

"1. That the lightning had not only descended upon the clock-tower of the church, and carried off the slates from its roof, but had struck and overthrown nearly fifty persons inside the edifice, and wrought great havoc on the high altar.

"2. That it knocked over and broke the pedestal on which the figure of Christ was raised to the level of the altar-screen, though this figure remained miraculously suspended in the same place — for this is what is reported.

"3. That it carried off the curtain covering the panels of the altar and threw it to the ground without breaking or melting any of its rings, which were made only of copper, and without displacing the rod above the ring-bolts on which they hung.

"4. That it upset the oil-lamp burning before the high altar.

"5. That it broke into two pieces the stone upon which the priest consecrates the Host.

"6. That it tore into four pieces the card on which the canon of the Mass was printed.

"7. That it tore the altar-cloth and the cloth which was over it—both of them in an extraordinary way, namely, in the form of a cross of St. Anthony.

"8. That the high altar was seen to be burning.

"9. That it burnt a part of the communion-cloth and of the tabernacle, upon which it formed several black waves.

"10. Finally that it imprinted upon the altar-cloth the sacred words of the consecration, beginning with *Qui pridie quam pateretur*, and going down to *Hœc quotiescumque feceretis in mei memoriam facietis*, inclusive; only omitting those which are usually set forth in special characters, namely, *Hoc est Corpus meum; et Hic est Sanguis meus.*

"What, I repeat, can you expect unphilosophical minds to make of so astonishing an affair as this? How account for the choice, the discernment, and the mysterious preference for some words over others. Which shall we consider the privileged words—those taken or those left? What is one to think of the extraordinary way in which the figure of the Saviour was left hanging? And of that strange imprint of the cross? How resist all the thousand delusions and uncertainties and fears the entire thing calls forth?

"I wonder whether the unfortunate Balthasar, when his eyes beheld the terrible sight of the unknown hand inscribing upon the walls of his banqueting-room the

announcement of his doom, can have been a prey to a greater variety of fears and tremors than those who witnessed or who even heard of the effects of the lightning at Lagny. For no doubt was felt that they were the outcome of supernatural forces—spirits alone could have worked these marvels; it was a question only whether they were the work of evil spirits or good. Some believed them to be the work of good spirits, deducing this from the omission of the words, *Hoc est Corpus*, etc., which they set down to a spirit of reverence for the sacred mystery.

"Others believed them to be the work of evil spirits, but here again there were different theories. Some held that bad spirits had perpetrated these things out of sheer wickedness, wilfully profaning the holy objects and suppressing out of contempt, or some other evil design, the words so essential to the mystery; others held that mere imps had been at work, actuated more by mischief than sinfulness, and wishing only to give amusement to themselves and others by the quaintness of their pranks. I myself do not share any of those theories."

Lamy's narrative proceeds to an examination of all the effects recorded, which he explains in the simplest way in the world, without having to have recourse to any occult causes. He comes, finally, to the last of all and the most extraordinary.

"Not wishing to put trust in anything but my own eyes, I went to the church myself, and the effects of the lightning I saw there repaid me for the trouble.

"I examined carefully the new imprint on the cloth. I found it very clear and fine, the letters well finished, but the ink a little indistinct, perhaps I should say faded. As M. le Curé de Saint-Sauveur (who was kind enough to show me everything) assured me that at the moment of the lightning the three-leaved card which contains the canon of the Mass lay between the altar-cloth and the small mat upon the stone on which the consecration takes place, folded in such a way that the printed side was next to the altar-cloth, I compared the characters printed by the lightning with the original lettering, and found that they corresponded exactly, except that they went from right to left, backwards, so that they had to be read with the help of a mirror, or else through the cloth from behind.

"I observed that the words which the lightning had not printed on the cloth, but had omitted, were done in red letters on the card, and were no more favoured nor ill-used than certain other marks without any significance also printed in red upon the card, and leaving no trace upon the altar-cloth."

The author proceeds to explain the so-called mystery, ascribing it to the difference between the two inks—the thick black ink and the thin red ink.

He examines also into the other phenomena, explaining them in the same way, like the sagacious and enlightened observer he was. It is clear, then, that the study of the phenomena of lightning is no new thing, and that it has been followed conscientiously for many centuries.

In the case of the canon of the Mass printed by the lightning at Lagny, the reproduction was by contact and pressure—it was not a case of reproducing distant objects as though by photography. Here is another case hardly less remarkable. The narrative is from the pen of Isaac Casaubon, in his *Adversaria*:—

"On a summer's day, about 1595, while divine service was in progress in the Cathedral at Wells, two or three thunder-claps were heard, of so terrible a nature that the whole congregation threw themselves down on the ground. Lightning followed at once, but no one was hurt. The astonishing thing about the affair lies in the fact that crosses were afterwards found to have been imprinted upon the bodies of some of those present at the service. The Bishop of Wells assured the Bishop of Ely that his wife told him she had a cross thus imprinted upon her; and that on his being incredulous, she had shown it to him, and that he himself found afterwards that he, too, was thus adorned—on his arm, if I remember right. Some had it on their breast, some on their

shoulders. It is from the Bishop of Ely I have these facts, which he tells me are well authenticated."

What shall we say now of the photographing of a landscape on the inside of the skin of sheep which had been struck by lightning? The record of this seems well authenticated.

In 1812, near the village of Combe-Hay, four miles from Bath, there was a wood composed largely of oaks and nut trees. In the middle of it was a field, about fifty yards long, in which six sheep were struck dead by lightning. When skinned, there was discovered on them, on the inside of the skin, a facsimile of part of the adjacent landscape. These skins were exhibited at Bath.

This record was communicated by James Shaw to the Meteorological Society of London at its session of March, 1857. Here are his own words:—

"I may add that the small field and its surrounding wood were familiar to me and my schoolmates, and that when the skins were shown to us we at once identified the local scenery so wonderfully represented."

Andrès Poey tells us of these other curious cases:—

In the province of Sibacoa, Cuba, in August, 1823, lightning imprinted on the trunk of a big tree a picture of a bent nail, which was to be found, bent in the opposite direction, embedded in one of the upper branches.

On July 24, 1852, in a plantation at St. Vincent in Cuba, a palm tree was struck by lightning, and engraved on its dried leaves was a picture of pine trees which surrounded it at a distance of nearly 400 yards.

Dr. Sestier tells us that after the 1850 meeting of the American Association, a person was killed by lightning while standing up near a whitewashed wall, and that his silhouette was fixed upon the wall in a dark colour.

With such facts before us, we seem bound to believe in the existence of some kind of especial rays, ceraunic rays, emitted by lightning, and capable of photographing alike on the skin of human beings, animals, and plants, more or less distinct pictures of objects far and near.

Decidedly, we have much to learn in this as well as in all the other branches of knowledge.

THE END

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